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THE CURRENTS OF THE PACIFIC OCEAN AND THEIR BEARING ON THE CLIMATES OF THE COASTS[1]

By Dr. H. U. SVERDRUP

SCRIPPS INSTITUTION OF OCEANOGRAPHY, UNIVERSITY OF CALIFORNIA

I FEEL greatly honored by addressing you here on this island which was made and made beautifully by man, the shores of which are washed by the waters of the Pacific Ocean, and which now during this great exposition offers a marvelous display of arts, crafts and industries from the many countries around that big ocean.

I stand here, however, with mixed feelings, partly because my personal experiences of the Pacific Ocean are limited and of recent years, and partly because I always feel that it is a shame to reduce winds and waves, the ever shifting sky of the sea, and the vast expanse of the ocean to a series of graphs in black and white such as those which I shall use to illustrate part of my address to-day. However, I can not bring to you the fogs of the Bering Sea, the blue waves of the trade-wind belts or the icebergs of the Antarctic. I have to present my subject in a cut-and-dried fashion, but I feel confident that you will not leave with the impression that the Pacific Ocean is as undisturbed and behaves in so law-abiding a fashion as appears from my graphs. You are familiar with the sea and know that it is ever-changing and tantalizing to those who try to understand its moods, but to-night I must generalize and simplify.

My address will fall into two distinct different parts. In the first place, I wish to give a review of the currents of the Pacific Ocean and, in the second place, I

[1] Address given at the Pacific Science Congress, July 27, 1939. Contributions from the Scripps Institution of Oceanography, New Series, No. 84.

wish to consider the influence which these currents exercise on the climates of the borderlands of the Pacific Ocean. The reasons for this division of the subject will be more clear when the factors which control the climate of any given region have been briefly discussed.

Under climate one understands, as you know, the average weather conditions during a long period of years, as expressed by means of average temperatures of months and seasons, maximum and minimum temperatures, amount of precipitation and distribution of precipitation, amount of cloudiness and sunshine, average and maximum winds and still other characteristics. I wish, however, to add that observations which in many localities have now extended over more than a century indicate that the climate of an area is not constant but is subject to variations the nature of which we know little about. In order to obtain a basis for comparison meteorologists have agreed that the climate of a region shall be defined by means of observations over a period of thirty years. Successive thirty-year periods will then show if changes take place and, before concluding to-night, I shall find opportunity to draw your attention to the fact that in certain regions conspicuous changes have occurred during the past few decades, changes which though probably not caused by ocean currents are related to them.

The climate of any region depends upon a number of factors, the most important being the latitude upon which is based the division in the three major climatic regions—the tropical, temperate and polar climatic zones. The climate is also closely related to the distribution of land and sea and to the character of the atmospheric circulation. The two most extreme types which are related to the distribution of land and sea are those which are known as continental and maritime climates. The continental type which is found over great inland areas is characterized by warm summers and cold winters and, therefore, by a wide range in temperature between summer and winter, and by warm days and cool nights and thus a wide range between day and night. Mostly, it is also characterized by little cloudiness and little precipitation. In contrast, the maritime climate which prevails over the oceans is characterized by a small annual variation in temperature, cool summers and mild winters, by a very small range of the temperature between day and night, and often by great cloudiness and considerable precipitation. In middle latitudes the general circulation of the atmosphere is directed from west to east, and east coasts are, therefore, greatly under the influence of winds blowing from a large continent, whereas west coasts are under the influence of onshore winds from the sea. In these latitudes the climate of the east coasts of the continents differs, therefore, characteristically from that of the west coasts, the east coasts having a more continental climate and the west coasts a more maritime climate. In equatorial regions the circulation is from east to west and the climatic conditions of the coasts are therefore reversed.

The great difference between the continental and the maritime climates is mainly due to the fact that the solid earth, in contrast to the ocean, does not store any appreciable amount of heat. Only the very surface is subjected to temperature changes and the surface temperature is, therefore, greatly raised in summer when heat is received from the sun, and greatly reduced in winter when excessive loss of heat by radiation takes place. Similarly, the temperature is increased during the day and reduced during the night. The ocean on the other hand can store large amounts of heat because in summer processes of vertical mixing distribute the heat absorbed from the sun over a relatively thick layer of water, the temperature of which will be only moderately increased. In winter the loss of heat similarly takes place from a considerable layer of water, for which reason the temperature decrease of the surface of the sea will be small. Even if no horizontal ocean currents existed there would be a marked difference between the climate of the land and that of the oceans, and a difference between the climate of the coast and that of the inland areas. The climate over the oceans would be much more uniform than that over the continents and the climate of the coasts would be milder than that over the inland. Even in such circumstances one could speak about the influence of the ocean on the climate of the coast. I do not, however, propose to discuss this general influence any further, because when dealing with actual conditions it must be taken into account that ocean currents exist which also tend to modify the distribution of temperature of the surface waters and to bring into one area waters which are abnormally warm and into another area waters which are abnormally cold. Thus, the circulation of the ocean will alter the climate over the sea itself and will modify the climate of the coasts, because the current flowing along one coast may be abnormally warm and the current flowing along another coast may be abnormally cold. The influence will evidently depend upon the character of the currents which, again, is controlled by the processes of heating and cooling to which the waters of these currents have been subjected in course of time. It is these particular modifications of the climates of the coasts which I propose to discuss, but before doing so it is necessary, as already stated, first to give a review of the character of the currents and especially to consider the distribution of sea-surface temperature which is related to these currents.

I have already mentioned that the climates of the coasts depend upon the prevailing winds. The same is true when dealing with the climates over the oceans and there the effect is intensified, because the currents

in the upper layers of the ocean also depend on the wind, the waters being to a great extent set in motion by the wind blowing over the sea. For two reasons one can not expect, however, to find a perfect agreement between the direction of the prevailing winds and the direction of the prevailing currents. In the first place, the boundaries of the oceans place certain limits upon the motion of the water. If the wind blows permanently against a coast the water can not be carried against the coast but must deviate to the right or to the left and instead of a flow towards the coast a current along the latter will develop. I shall be able to show several examples of this process when dealing with the actual currents of the Pacific. In the second place it must be taken into account that the motion of the sea is also governed by certain laws, for which reason some ocean currents may be expected to deviate from the wind system. I shall find opportunity to show examples of such currents as well.

Let us first consider the prevailing winds over the Pacific Ocean in summer, as related to the distribution of atmospheric pressure (Fig. 1).[2] In this season we find one high-pressure area located over the eastern part of the North Pacific, and another over the eastern part of the South Pacific, separated by a broad belt of low-pressure extending clear across the Pacific Ocean somewhat north of the Equator. The high-pressure area of the North Pacific dominates completely the wind system over that part of the ocean. Near the American coast strong northerly or north-

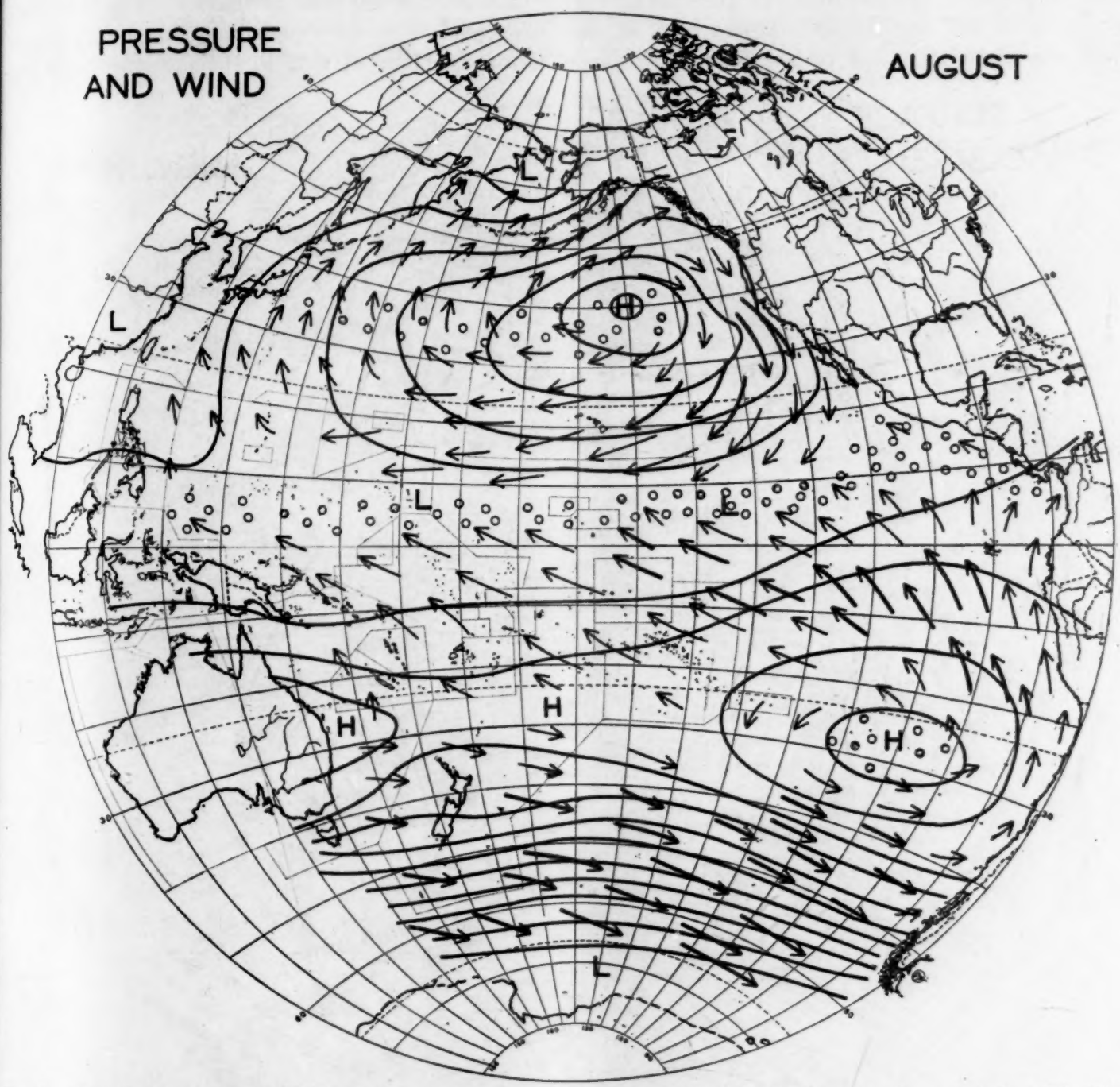

FIG. 1. Distribution of atmospheric pressure and prevailing winds over the Pacific Ocean in August (after Schott).

[2] This and the following charts are based on the charts published by G. Schott in his book: "Geographie des Indischen und Stillen Ozeans," Hamburg, 1935. Maps 1–4 are reprinted from Robert B. Hall's "Series of Maps" published by John Wiley and Sons, Inc.

westerly winds prevail but, advancing south, the winds turn through northeast to east-northeast blowing as the steady trade winds between the latitudes 10° N and 25° N. The persistent northerly winds along the west coast of North America and the steady trade winds represent the most conspicuous features of the picture. Over the western and northern part of the Pacific the winds are more variable and blow there mainly from the south, and in the northern part from the southwest. It should be emphasized that this picture represents only the average conditions and that except in the trade-wind belt numerous disturbances occur associated with traveling low-pressure areas.

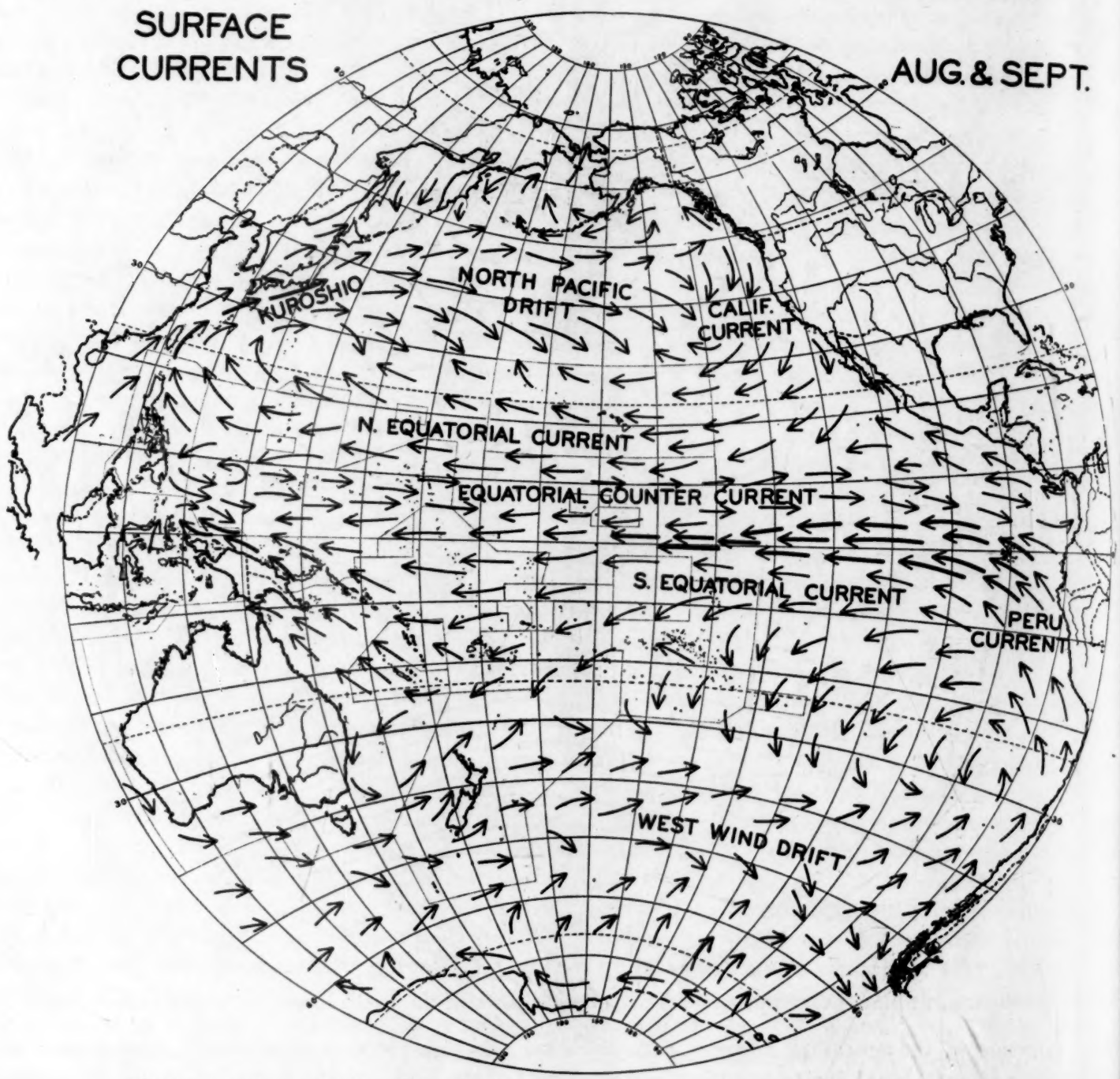

FIG. 2. Surface currents of the Pacific Ocean in August and September (after Schott).

The high-pressure area over the South Pacific similarly dominates the wind system over that ocean. There, the southeast trade winds which blow with high velocity represent the most conspicuous feature, but to the south of the high-pressure area, strong westerly winds prevail between latitude 40° S and nearly to the Antarctic Continent. The southerly winds along the west coast of South America correspond to the northerly winds off the coast of California.

The surface currents in summer (Fig. 2) show a close relation to these prevailing winds, but it is immediately observed that in the northern hemisphere the prevailing current deviates to the right of the direction of the wind, whereas in the southern hemisphere it deviates to the left. Within the belt of the northeast trade winds the north equatorial current flows due west, and, similarly, within the belt of the southeast trade winds in the South Pacific the south equatorial current also flows due west. Along the coasts the currents must, naturally, follow the coast lines, but even there a tendency to deviate from the

coast is seen, corresponding to a deviation from the wind direction to the right or to the left. This deviation of the current from the direction of the wind is caused by the rotation of the earth but need not be further discussed here. The main point in this connection is that a general agreement between prevailing winds and currents exists. Attention is drawn, however, to the fact that the intensity of the Kuro Shiwo, the current flowing north along the southern coasts of Japan, is much greater than should be expected when considering only the weak and variable southerly winds. This current must, therefore, be regarded as a continuation of the north equatorial current. The flow to the south along the Island of Mindanao, the southern of the Philippine Islands, represents another branch of the same current. This current, which flows against the wind, represents a good example of the effect of the boundaries.

An even more striking exception from the agreement between wind and current is found. Between the two equatorial currents towards the west is imbedded a swift counter current running towards the east clear across the Pacific Ocean. The counter current is partly met with in the region of calms between the two trade wind systems, but in several instances the current runs directly against the prevailing wind.

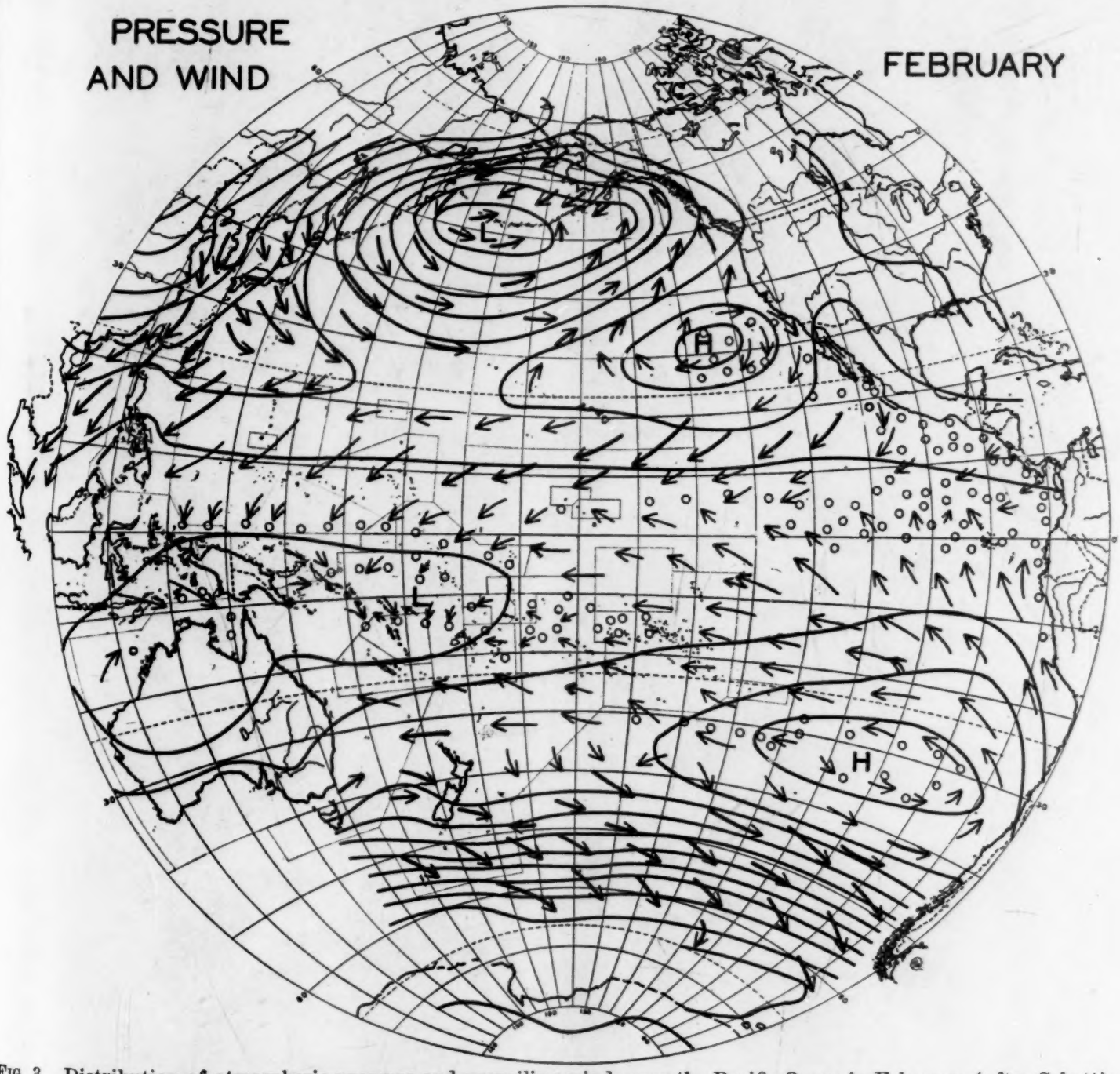

FIG. 3. Distribution of atmospheric pressure and prevailing winds over the Pacific Ocean in February (after Schott).

It has been found that this counter current is very shallow and that the development is probably closely associated with the entire dynamics of the flow, but here it is not necessary to enter upon these matters because the counter current has only a limited influence on the climates of the adjacent coasts. The counter current serves, however, to bring out the facts that the ocean currents depend not only upon the wind, but that the types of flow which can exist in the sea must also be considered, and that the relation between wind

and current is more complicated than would appear from the brief presentation which is given here. It should also again be emphasized that the picture is greatly simplified and that superimposed on the average flow are numerous swirls and eddies and the currents are changing and shifting as are the winds.

In winter much greater discrepancies are encountered between the prevailing winds and currents. The high-pressure area of the North Pacific Ocean is in winter found further south and closer to the American coast (Fig. 3). This high-pressure area no longer completely dominates the circulation, as was the case in summer, but the more conspicuous feature is now presented by the low-pressure area in the region of the Aleutian Islands and by a tongue of high-pressure extending from the Asiatic continent. Along the west coast of America the prevailing northerly winds have been replaced by weak and variable winds, although the direction from the north is still the most frequent. The northeast trade winds are still very conspicuous and have increased in velocity because a steeper barometric gradient has been created by the approach of the high-pressure area towards the Equator. They blow with great permanency over a large area of the ocean between latitudes 5° N and 20° N. The most conspicuous contrast between winter and summer is found in the western part of the Pacific, where the weak southerly winds of the summer have been replaced by strong northerly or northeasterly winds blowing from the Siberian high-pressure area, and in the northern part of the ocean, where strong westerly winds prevail.

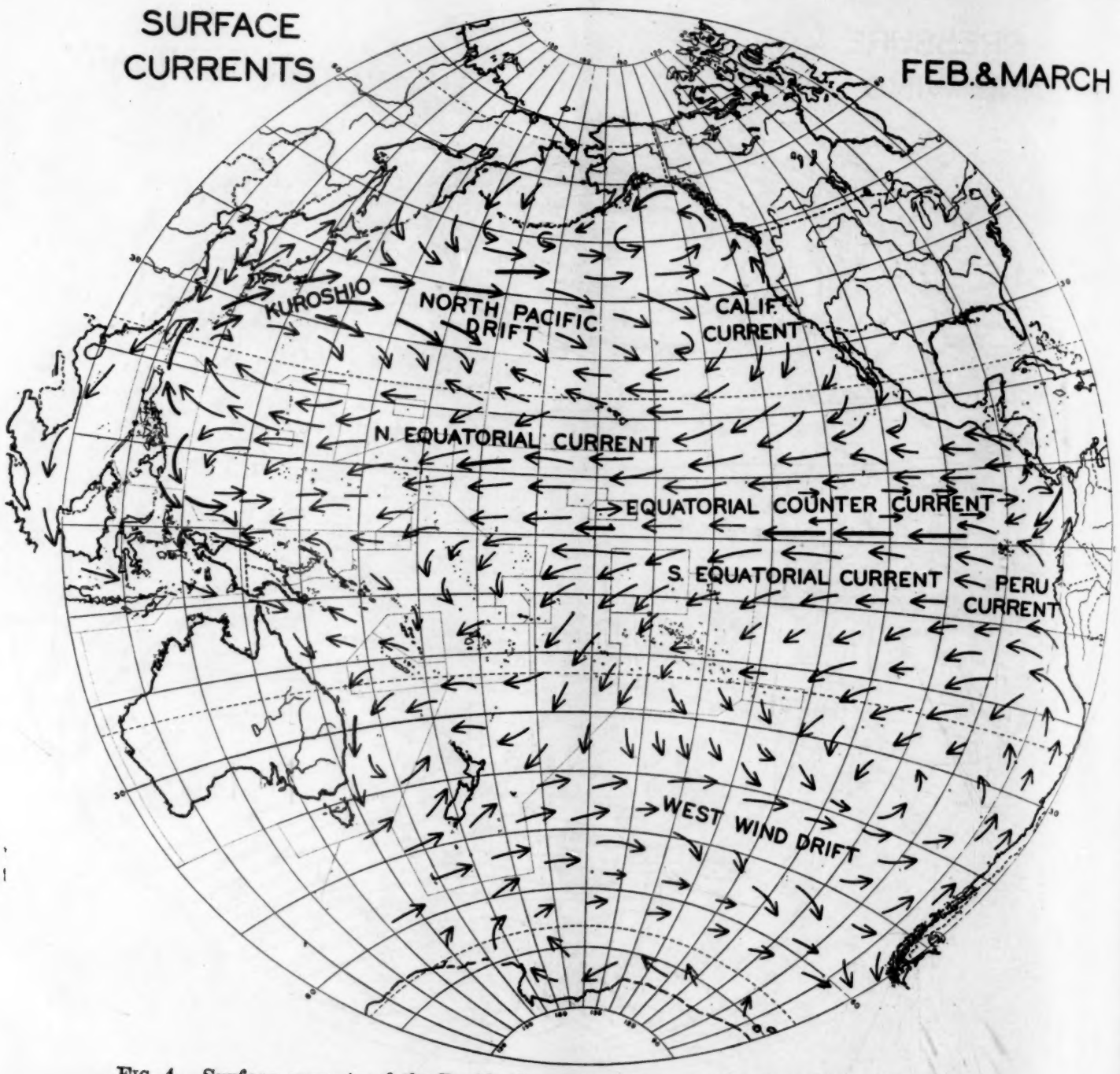

FIG. 4. Surface currents of the Pacific Ocean in February and March (after Schott).

The high-pressure area over the South Pacific Ocean is still the conspicuous feature over that portion of the

sea, but it has moved away from the Equator. The barometric gradient has decreased, for which reason the southeast trade winds have decreased greatly in strength. The intensity of the westerlies in the southern part of the ocean has also decreased.

The surface currents do not show such conspicuous changes as the wind system does (Fig. 4). The north and south equatorial currents are still well developed and particularly the north equatorial current is more conspicuous than in summer. The counter current is still present but appears to be much narrower. A conspicuous discrepancy between the prevailing winds and the current is now found in the western part of the North Pacific, where the north equatorial current bends to the north and continues along the coast of Japan as the Kuro Shiwo, flowing nearly directly against the strong winds from the north. Along the coast of California the current still flows south at some distance from the coast, but an inshore current flowing north has developed. In the southern hemisphere the south equatorial current has decreased in intensity, but on the whole the picture has remained unaltered.

The turn towards the north of the north equatorial current and the continued existence of the Kuro Shiwo presents an excellent example of the effect of the boundary of the oceans upon the development of the currents. The flow of the north equatorial current towards the west is maintained by the permanent trade winds, and the North Pacific drift from the west to east in higher latitudes is intensified by the strong westerly winds. Water is therefore transported towards the coast of the Philippines and must bend north along the coast of Japan, or south along the Philippine Island of Mindanao, where the current is strengthened, probably owing to the northerly winds. The greater development of the cold Oya Shiwo north of Japan may also be greatly due to the stronger winds from the north.

The inshore flow along the coast of California is an interesting example of a counter current which probably can not be explained as the result of wind action but appears to represent a link which is dynamically conditioned, as is the case with the equatorial counter current.

The main feature of the Pacific surface currents is thus that along the western boundaries of the ocean equatorial water is transported towards higher latitudes, whereas along the eastern boundaries water from high latitudes is transported towards the equatorial regions. These transports of water are directly reflected in the distribution of surface temperatures. In the North Pacific Ocean water of a temperature of 70° (F.) is in August found off the coast of Japan in latitude 40° N, whereas off the American coast water of that temperature is met with in latitude 25°. The bend to the north of the isotherms in the western part of the ocean and to the south in the eastern part is closely associated with the movement of the water masses, the warm water of the Kuro Shiwo travels from the equatorial regions towards the north, whereas the cold water of the California currents flows from higher latitudes towards the south. In the Gulf of Alaska the flow is, however, from the south, and there relatively warm water is found.

Along the west coast of the United States the effect of the flow from the north is accentuated by the upwelling near the coast. North of San Francisco, in latitude 40° N, the average surface temperature of the water near the coast is on occasions as low as 50°, whereas in the same latitude off Japan the temperature is 70° or higher. The very low temperatures are due to upwelling, which is a direct effect of the prevailing winds blowing parallel to the coast. Owing to the rotation of the earth the surface current tends to be deflected to the right of the wind and, as a consequence, the light and warm surfaces of the waters are carried away from the coast and must be replaced by water from some greater depth. An overturning takes place and because the deeper water has a lower temperature cold water becomes accumulated along the coast. I wish particularly to point out that the upwelling water does not come from any great depth. The overturn takes place within the upper 500–600 feet and it is therefore essentially a process which takes place within the surface current. The upwelled water does not represent Arctic or Antarctic deep water as is occasionally stated.

In the southern hemisphere a similar process of upwelling acts along the coast of Peru where water of a temperature as low as 62° is found in latitude 2° S., whereas in the corresponding latitude on the coast of New Guinea the surface temperature is about 83°. A tongue of low temperature extends along the equator and is associated not only with the upwelling along the coast of Peru, but also probably with a divergence of the south equatorial current tending to raise the subsurface waters.

In the winter the effect of currents on the distribution of surface temperatures is much less conspicuous in the North Pacific than it is in summer. In middle latitudes there still exists a somewhat similar contrast between the coasts on the western side and the eastern side of the North Pacific. In somewhat higher latitudes the effect of the currents is more conspicuous. In winter the cold Oya Shiwo brings water of very low temperature to the northern coasts of Japan, whereas the North Pacific drift brings waters of relatively high temperature to the Gulf of Alaska. In the southern hemisphere the upwelling along the coast of Peru is as conspicuous as in winter and the tongue of low temperature along the Equator is still present.

Leaving the question of the ocean currents and turn-

ing to the climate I shall have to limit my discussion to a consideration of the temperature conditions. A chart of the air temperature over the Pacific and the adjacent coasts in summer shows that over the ocean the air temperature is very nearly the same as that of the surface waters. The isotherms show the same bends, and in the North Pacific the northward trend of the isotherms along the coast of Japan and the southward bend along the American coast are particularly conspicuous. Similarly, in the southern hemisphere the effect of the cold current along the coast of Peru is clearly visible.

From the course of the isotherms it is evident that the effect of the currents is limited to a very narrow coastal strip. This is particularly seen when examining the air temperature on the west coast of North America and the west coast of South America. Close to the coast the isotherms bend towards the Equator, but over the land they turn sharply away from the Equator. An air temperature of 70° is thus, on the coast, found as far south as off Lower California but, inland, north of the latitude of Vancouver. In the southern hemisphere a temperature of 70° is, on the coast, found nearly at the Equator, but inland south of latitude 30°. Along the coast of Japan the surface temperature of the sea also tends to reduce slightly the air temperature on the coast, but there the effect is very small as evident from the small bends of the isotherms. Thus it appears that in summer the influence of ocean currents is particularly conspicuous along the west coasts of the American Continents, but of small importance along the east coast of the Asiatic Continent.

In February the influence of the ocean current is in the northern hemisphere much less striking, except that in the Gulf of Alaska the coast has a much higher temperature than the inland, owing to the relatively warm water which flows through the Gulf of Alaska. Further south along the west coast of America the influence of the sea decreases. In the Japan region and along the east coast of the Asiatic Continent the air temperature is in winter much lower than the temperature of the adjacent sea, and there the cold air which flows out from the Siberian high-pressure area exerts a greater influence than do the ocean currents, but the latter tend to modify the winter cooling. Conditions in the southern hemisphere are, in February, naturally related to those which existed in the northern hemisphere in August.

The general features which have been discussed so far can also be brought out better by considering specific examples of difference in the annual march of temperature on both sides of the Pacific Ocean. Yokohama and Berkeley are nearly in the same latitude but the annual march of temperature in these localities is widely different, as evident from Fig. 5, in which are shown the mean monthly temperatures. At Yokohama the average temperature of the coldest month is as low as 37° but the warmest month has an average temperature of nearly 80°. The great range of 43° clearly demonstrates the continental character of the climate of Yokohama. In Berkeley on the other hand the coldest month has an average temperature of 48° and the warmest is 62°, and the small range of only 14° clearly demonstrates that Berkeley, from this point of view, has a maritime climate.

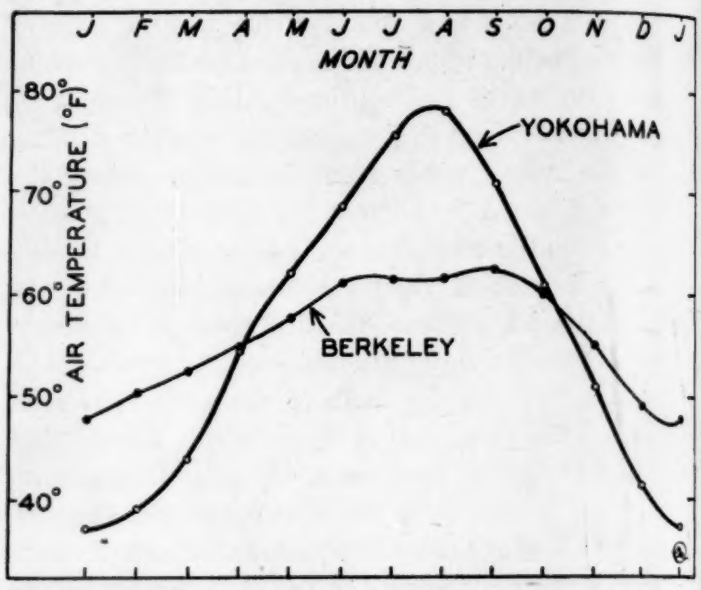

FIG. 5. Mean monthly air temperatures at Yokohama and at Berkeley.

A comparison of the air temperature with the water temperatures off the coasts is of further interest. Off Yokohama the water temperature varies during the year between 62° and 80°, and in nearly all months the water is warmer than the air. The great difference in winter is particularly striking and is due to the fact that the northerly winds bring air of low temperature. At Berkeley on the other hand the water temperature off the coast varies only between 52° and 58°. The coldest water is found in April and May because in these months the upwelling which was previously mentioned is most intense. The air temperature remains throughout the year very close to the water temperature but is generally somewhat higher. It is quite evident that the low spring temperatures at Berkeley are closely associated with the cold waters off the coast, and that at Berkeley the air temperature is to a great extent controlled by the temperature of the currents off the coast in contrast to the conditions at Yokohama. At Yokohama the warm water off the coast makes the winter milder, but the air temperature is not completely controlled by the water temperature. The difference is due to the fact that in Yokohama offshore winds prevail during the winter, whereas in Berkeley onshore winds prevail. The specific influence of the

ocean currents gives Berkeley an abnormally low summer temperature and a relatively high winter temperature.

The annual march of precipitation in the two localities also shows a conspicuous difference. At Yokohama the precipitation is considerable in all months of the year, the mean monthly values varying between about 2.5 inches in winter up to 10.6 inches in the early fall. The excessive rains in the month of August, September, October are in part attributed to the influence of the adjacent sea because the path followed by the areas of low pressure will, to a considerable extent, be controlled by the temperature distribution over the ocean. The currents off the coast are therefore of considerable importance to the climate of Yokohama, although the continental character prevails as far as the temperature is concerned. At Berkeley on the other hand no precipitation falls in midsummer, but the winter months have up to 4 or 5 inches. The lack of precipitation in summer can in this case be ascribed partly to the effect of the inland and, as far as precipitation goes, Berkeley is more continental in character, although the temperature curve is distinctly maritime in type. Thus the bearing of the currents on the climate is a complicated one and it is here possible only to draw attention to some of the more outstanding features, and to pay particular attention to the distribution of temperature.

Turning to the southern hemisphere it is again of interest to compare conditions in the east and in the west, and for this purpose Fig. 6 shows the air and

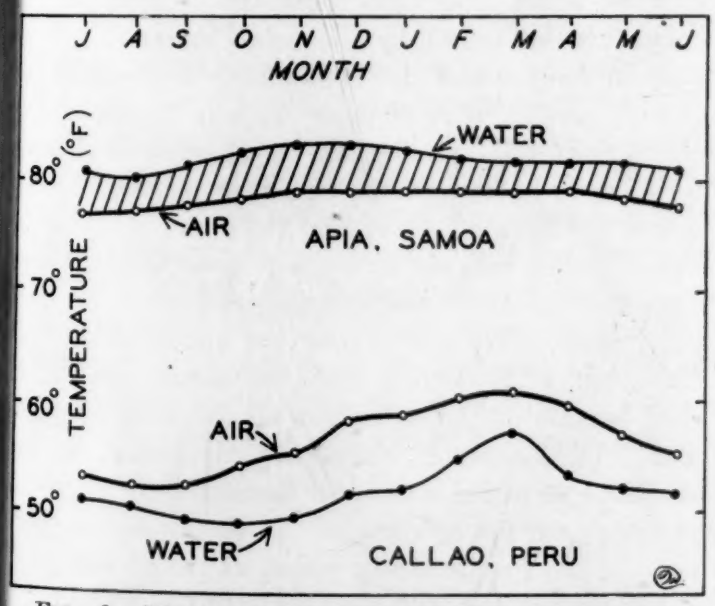

FIG. 6. Mean monthly air temperatures at Apia, Samoa, and at Callao, Peru, and mean monthly sea surface temperatures off the coasts.

water temperatures at Callao, Peru, and Apia, Samoa, which are located in 12° S and 14° S., respectively. The curves have been plotted with the month of January in the center, because January is a summer month in the southern hemisphere.

At Apia, Samoa, the annual range of the air temperature is very small and the air temperature always remains somewhat lower than the temperature of the water, which is about 80° throughout the year. At Callao, Peru, the air temperature is much lower than it is at Apia and varies between 52° in winter and 61° in late summer. The air temperature is throughout the year higher than the temperature of the waters off the coast which varies between 49° and 57°. It can not be doubted that both at Apia and at Callao the air temperatures are completely controlled by the temperatures of the water. At Callao the low water temperatures are the results of the character of the currents off the coast which carry cold water from higher latitudes towards the Equator and within which the surface temperature is further reduced by upwelling. The lowest water temperatures occur in the months of October, which in the northern hemisphere corresponds to April, the month of the lowest water temperatures off the coast of California.

The most striking conclusion which can be based on this very brief review is that a direct influence of the ocean currents upon the climates of the coasts is particularly found on the eastern side of the Pacific Ocean, whereas the coasts on the west side are only slightly influenced by the currents. On the eastern side of the Pacific the cool summers on the coast of South America and on the coast of North America between Cape San Lucas at the southern end of Lower California and towards the strait of Juan de Fuca are directly related to the character of the currents. Similarly, the mild winters of the coast of British Columbia and Alaska are directly related to the relatively warm currents which bend north into the Gulf of Alaska. The direct influence of the sea is, however, limited to a very narrow coastal zone, as you all know from personal experience.

When discussing the influence of oceans on climate, the effect of the northern branch of the Atlantic Drift, or the Gulf Stream, upon the climate of northwestern Europe is very often considered the most magnificent example of such influence. In this case the influence is not limited to a narrow coastal strip because the entire character of the atmospheric circulation appears to be modified by the surface temperatures of the ocean. The high temperature of the Atlantic water which enters the North Sea north of Scotland causes the atmospheric lows to take a more northerly path and thus to bring warm maritime air in over large portions of northwestern Europe. The areas which thus come under the influence of ocean currents are much greater than the coastal areas of the Pacific, but if attention is paid only to the very coasts the modifications of the climate which may be ascribed to currents are as great along the coast of the Pacific Ocean as anywhere else in the world.

In conclusion, it may be of interest to examine the question whether changes of climate can be attributed to changes of ocean currents. It has then in the first place to be observed that the development of ocean currents depends to a great extent upon the boundaries of the ocean and the depth to the bottom. Major changes of the bottom configuration or the coast lines may lead to major changes in the flow of the water and thus to appreciable alterations of the climate. Scotland and Iceland are connected by a submarine ridge. If this ridge should rise, the volume of Atlantic water flowing into the North Sea would be reduced, and if the passage should become completely closed the effect upon the climate of the Scandinavian countries would be disastrous, and these countries would perhaps face a new glacial period. On the other hand, if the Aleutian Islands should sink into the sea and Bering Strait should widen and deepen, the Pacific west wind drift might turn north; Alaska would probably receive a much milder climate than what it has now, and the Yukon Valley might become covered with orchards. Such changes may take place during long geological periods, and it is possible that changes of this nature have had bearing on the past climates of the Pacific area and may receive bearing on the climates of a very distant future, but in a discussion of climatic changes in geological periods many other factors enter in, particularly changes in solar radiation.

It is of more immediate interest to examine the question whether variations of short duration in the character of the currents occur, and, if so, whether these variations will be reflected in similar changes of the climates of the coasts. This question is a very complex one because the ocean currents are determined to such an extent by the prevailing winds that any change in the general circulation of the atmosphere will lead to a change in the ocean currents, but such a change in the general circulation will also have direct bearing upon the climate of any particular region. It is therefore difficult to discriminate between the direct influence upon the climate of a change in the atmospheric circulation and the indirect influence which is brought about by an alteration of the ocean currents. We have a striking example of this condition in northwestern Europe. During the last thirty years the winters of northwestern Europe have become milder, and the most conspicuous change has taken place in northern Norway and in Spitsbergen. In Spitsbergen the average winter temperature has, during the last decade, been about 15° above the average winter temperature of forty years ago. There is good evidence that this rise of winter temperature has been accompanied by a greater transport of Atlantic water towards the north. The increase in the volume of warm water flowing along the coast has certainly a bearing on the climate but the greater part of the change may not have been directly caused by such greater transport. Both the major effect on the climate of Spitsbergen and the effect on the currents of the North Atlantic Ocean may be due to a displacement towards the north of the tracks of the low-pressure areas. Such a change of the atmospheric circulation may again be due to a slight alteration of the amount of energy received from the sun which keeps the atmosphere running and maintains the ocean currents.

It should be borne in mind that the atmosphere and the ocean represent two delicate thermodynamic machines which are interdependent. A change in the performance of one of them leads to a change in the other which brings about a new reaction in the first one. A balance—a steady state is never attained. In order to understand the complex sequence of events and to be able to discriminate between changes in climate caused directly by changes in atmospheric circulation and indirectly by changes in ocean currents, it is necessary to acquire a better knowledge of both the atmosphere and the ocean and of the interaction between the two. At the present time it is possible only to state empirically how the climates of the coasts are influenced by the ocean currents. If we wish to comprehend the mechanism of this influence and to predict what changes we may expect as the circulation of the atmosphere is subjected to changes we have to know how the enormous machines represented by the atmosphere and the ocean really work. When dealing with the atmosphere great advances have been made in recent years, largely because it has been possible to secure and to interpret upper-air observations, but when dealing with the oceans progress is slow because of the difficulties of obtaining adequate data. This, however, should not discourage us but should be an added reason for increasing the efforts in the study of the currents of the oceans and particularly of the Pacific Ocean which, at the present time, is less known than any other ocean in the world.

OBITUARY

EDWIN MORRISON

ENDING an active life of seventy-eight years and an actual teaching career of half a century, Professor Edwin Morrison passed away on July 16, 1939, at his home in East Lansing, Mich.

For the last twenty years he had been a member of the department of physics at Michigan State College, retiring from active duty in 1936. He was born on March 5, 1861, at Bloomingdale, Ind., where his boyhood was spent and his education begun. While at-

tending the Bloomingdale Academy he decided to become a teacher of science. He continued his education at Earlham College, graduating in 1888. Three years later as a result of summer school work he received an M.S. degree from Indiana University. He continued his work at the University of Chicago for several summer sessions, where he came under the influence of Dr. R. A. Millikan, with whom he worked on a number of special problems.

Professor Morrison held positions as follows: instructor in science at the Pacific Academy at Newberg, Ore., and at Spiceland Academy, Indiana. When the Pacific Academy became a college, he went back as head of the department of science. In 1901 he became head of the department of physics and chemistry of Penn College at Oskaloosa, Iowa, and in 1906 was called to Earlham College, his alma mater, to become head of the department of physics, from which post he moved to Michigan State College in 1919.

In all his teaching he used and promoted the laboratory method, and wherever he went he built up a good laboratory for the teaching of undergraduate physics. He was a member of the American Association for the Advancement of Science, the American Physical Society, the American Association of Physics Teachers, the American Optical Society and the Indiana Academy of Science.

C. W. CHAPMAN
O. L. SNOW

WILFRED AUGUST WELTER

DR. WILFRED AUGUST WELTER, professor of biology and head of the department of biology of Teachers College, Morehead, Ky., died in an automobile collision on December 20. He was born in Creighton, Nebr., on March 29, 1906. In 1911 he moved with his parents to a farm north of Verndale, Minn., where he attended a grade school and the Verndale High School, from which he graduated in 1922. From high school he entered the Teachers College at St. Cloud and graduated in 1924. He obtained the bachelor's degree from the University of Minnesota in 1926 and the master's degree from the Iowa State College in 1927. He taught one year in the Teachers College at St. Cloud and one at the Teachers College in DeKalb, Ill., before he entered Cornell University, from which he received a Ph.D. degree in ornithology in 1932.

The degree was conferred on him while he was very young, and he came to Morehead with an eager step and a boyish smile which endeared him to all. He was a man of unlimited capacity, one who was rapidly climbing professionally. He was the ideal of all students and as head of the department of biology he influenced them to take up graduate work.

Dr. Welter collected specimens and built up a museum of mammals, reptiles and birds. He made a survey of the fish in Kentucky streams and added a large collection of specimens to the museum. He worked with the government in bird feeding and bat banding. He found and classified rare salamanders. He made colored movies of the birds, flowers and animals of this region and was much sought as a lecturer at educational and conservation meetings. He established a wild flower garden on the hill behind the college to preserve rare specimens in their natural habitat. He assisted in training school supervisors to teach nature units. He wrote articles for science magazines, and maintained membership in organizations related to his field.

His favorite pursuits were connected with his professional work—conservation of wild life, fishing, collecting, making colored movies of birds, flowers and animals, studying nature at close range, out-of-doors cooking, field trips, boating, canoeing, travel by motor car and building a museum of wild life for the college.

His passing is a great loss to Morehead College and to the study of science in Kentucky.

A CORRESPONDENT

RECENT DEATHS

DR. JOHN HENRY TANNER, professor emeritus of mathematics at Cornell University, died on March 11 at the age of seventy-nine years.

THE death is announced of Lieut.-Colonel J. A. Amyot, Canadian deputy minister of pensions and national health, formerly professor of hygiene in the University of Toronto, at the age of seventy-two years.

SCIENTIFIC EVENTS

THE INVENTIONS BOARD OF THE CANADIAN GOVERNMENT

AN Inventions Board has been established by the Canadian Government to deal with the growing volume of inventions and suggestions intended to further Canada's war effort which are being received by the various departments of the government, according to an announcement made by the Hon. W. D. Euler, Minister of Trade and Commerce and chairman of the Committee of the Privy Council on Scientific and Industrial Research.

The establishment of the Inventions Board provides a means whereby ideas and inventions submitted by citizens of Canada and abroad can be carefully examined, and promising proposals cleared to the proper authorities.

The board itself is composed of Dean C. J. Mackenzie, acting president of the National Research

Council, *chairman;* Lt.-Col. K. S. Maclachlan, acting deputy minister (Naval and Air), Department of National Defence; Colonel H. Des Rosiers, acting deputy minister (Militia), Department of National Defence; W. R. Campbell, chairman, War Supply Board. S. J. Cook, officer-in-charge, Research Plans and Publications Section, the National Research Council, has been named secretary of the board.

The Inventions Board has made all its appointments from among the members of the Public Service in Canada. This has been done partly as a measure of economy, but more particularly because officials of the National Research Council and of the various government departments are well qualified to serve as members of a committee to examine inventions and ideas and to segregate those which offer promise of useful application from those which are technically unsound. The secretary of the board and the members of the examining committee have been chosen from the staff of the National Research Council. The members of the consulting panel, to whom doubtful questions will be referred, include the four directors of the laboratory divisions of the National Research Council, representatives from each of the three Services (Navy, Militia and Air), of the Department of National Defence, and appointees from the staffs of the War Supply Board and the Patent Office.

All proposals received will be considered in the first instance by the examining committee. Those which offer promise will be reviewed by members of the consulting panel, and the proposals which meet with the approval of these two groups will then be considered by the board.

EXPEDITION TO THE CARIBBEAN

Two members of the expedition to the Caribbean of the Field Museum—Rudyerd Boulton, Jr., curator of birds, and D. Dwight Davis, assistant curator of anatomy and osteology—have returned to Chicago. The expedition was led by Leon Mandel, a Chicago merchant, on his yacht *Buccaneer*.

Since the first of January the *Buccaneer* has been piloted between and around the coral reefs and through remote and tortuous channels, purposely seeking out all the spots which the navigators of most vessels try to avoid.

The places visited—Cuba, Honduras, Mexico and British Honduras, some of them scarcely a square mile in extent—are of great interest biologically. The collections include approximately 150 exotic birds, 350 reptiles and amphibians, 500 specimens of fishes, many of them vari-colored and strange in form and quantities of mollusks, marine invertebrates, microscopic creatures accumulated in masses known as plankton and other minute organisms. In most of these places little or no scientific collecting had been done before.

At Half Moon Cay, British Honduras, after material had been collected for exhibits representing a great colony of red-footed boobies which live there, a storm of hurricane force suddenly struck the *Buccaneer,* causing the breakage and loss of heavy chains and anchors and a hurried departure out to sea for safety.

The most isolated of the islands visited was Swan Island, which consists of two mile-square specks of land belonging to the United States. It lies almost midway between Cuba, Honduras and the Yucatan Peninsula. There the expedition obtained specimens of Nelson's yellow warbler and a species of palm lizard, both of which are hermit-like creatures, inhabiting, so far as is known, no other place. Also collected there were representatives of a nesting colony of brown boobies and various sea birds.

What is perhaps the largest colony of sea birds in the West Indies was found on Mujeres, Cancun and Contoy Islands off the coast of Yucatan. So far as known, no other ornithologists have reached these spots before. There collections were made of pelicans, cormorants, frigate and other birds, including, on Contoy, a specimen of the great white heron.

In the Bay Islands, belonging to the Republic of Honduras, the expedition obtained snakes and lizards by the hundreds. Off Glover's Reef, British Honduras, using a special small motor cruiser carried aboard the larger vessel, the principal fish collections were obtained in the waters over a coral reef, fifteen miles long and five miles wide, which represents the ultimate development of coral reefs to be found in the West Indies. In the clear water, fish could be seen to depths of about 100 feet, swimming among the coral "trees" as much as thirty to forty feet in height.

Other places in which collections were made are Misteriosio Bank, Rio Encancada (Enchanted River) in the Zapata Swamp of Cuba and Turneffe Cay. The primary objectives of the expedition were to make an assay of the wild life of these little known places, and to obtain for the museum exhibits and study collections a representation of the faunas of such circumscribed ranges for comparison with other faunas which usually range for thousands of miles.

TIMEPIECES OF THE JAMES ARTHUR COLLECTION AT NEW YORK UNIVERSITY

THE James Arthur Collection of Clocks and Watches at New York University, already one of the largest in the world, recently was augmented by the acquisition of 275 antique timepieces, comprising the entire collection of the late John Arthur, of Brooklyn. It has also been increased by the acquisition of a number of rare early American and English clocks, including works of Simon Willard, David Rittenhouse, Theodore R. Timby and John Arnold. The watches, dating back

to 1600, include three valuable works of Brequet, the French watchmaker, and a jeweled-enameled timepiece with gold movements made by William Ilbery of England about 1810.

Among the antique American clocks was a tall hall clock made by David Rittenhouse about 1760, believed to be one of the earliest works of this Colonial craftsman. The ornamented brass dial bears both Roman and Arabic figures and indicates seconds, minutes, hours and the days of the month. Another addition is a solar timepiece designed by Theodore Timby, of Baldwinsville, New York. He arranged a terrestrial globe in such relation to a dial plate and index on a clock that the culminating time of the sun and the mean time can be observed simultaneously. It was built about 1870. The globe on the clock was manufactured by Gilman Joslin, of Boston, one of the foremost mapmakers of his time. The Simon Willard clock, one of the new acquisitions, was built as a timepiece to check astronomical observations. It stands in a glass globe 32½ inches high, believed to be the original, and has a center movement, single weight and anchor escapement. The "Regulator Clock" made for and to the specifications of James Sarratt, the inventor of the "Cosmochronotrope," was acquired by the collection last year. It was built by George A. Jones and Company, of New York City, somewhat prior to the "Cosmochronotrope" in about 1875. It has a "dead beat" escapement with a seconds pendulum and has been constructed to allow temperature compensation throughout, particularly between pallet and pendulum. Among the new English pieces is a John Arnold chronometer which bears the number 491, and was built about 1760, in response to the British government's desire for instruments that would keep correct time at sea.

The James Arthur Collection of Clocks and Watches now consists of more than 2,000 objects which present the story of the evolution of timekeeping from the simplest sundial and hour glass to clocks having four dials and complicated mechanism. It was assembled by the late James Arthur, a Brooklyn manufacturer, over a period of forty years at a cost of more than $150,000 and was presented to New York University in 1926. Since that time rare clocks and watches, enough in number and value to constitute an important collection in themselves, have been added to the original gift.

Until his death in 1938 Dr. Daniel Webster Hering, emeritus professor of physics, was curator of the collection. He was succeeded by Dr. Carlos de Zafra, of the department of mechanical engineering.

THE GRAY HERBARIUM OF HARVARD UNIVERSITY

MORE than 39,000 mounted flower specimens from all over the world were added to the Gray Herbarium of Harvard University last year, bringing the collection of flowering plants and ferns to a total number of 1,033,850 sheets, according to the annual report of Professor Merritt L. Fernald, director of the herbarium, as summarized in *The Harvard Alumni Bulletin*.

Noting an "intense activity in botanical exploration at the present time," Professor Fernald reported that among the important gifts of the year were a series of southeastern state orchids, plants from the Atlantic States, Nevada, tropical America, Chile, Alaska, Iceland, Yunnan, California, Transcaucasia, Belgian Congo, Russia and Siberia and the eastern Mediterranean region. More than 16,000 specimens were collected by members of the staff on expeditions to the coastal plains of Virginia, Dominica, North Carolina, South Carolina and other areas.

Dr. Fernald pointed out that because of the war much of the important loan activity between botanists in the United States and Europe must temporarily cease. During the past year more than 12,000 duplicate specimens were sent out to fifty-four institutions and individuals in the United States and to twenty-seven foreign institutions. In addition, loans of over 8,000 specimens were received and loans of more than 12,000 were sent out.

Bequests of over $27,000 were made to the permanent funds of the herbarium. The sum of $1,242 was given by forty-four friends of the institution, and further funds were received from the American Philosophical Society for field work in Virginia and South Carolina. In addition, under the will of the late Earl Willson Bemis, of Worcester, long a member of the Overseers' Committee to Visit the Herbarium, the residue of an estate which is expected to amount to about $85,000 was bequeathed to the herbarium.

During the year 5,310 specimens were received from collectors and students for critical study and identification. Thirty-one investigators from outside the university used the facilities of the herbarium in furthering their researches.

THE ASSOCIATED HOSPITAL SERVICE OF NEW YORK CITY

THE Board of Directors of the Associated Hospital Service of New York City has issued its annual financial statement showing assets of $4,198,220. The growth of the non-profit three-cents-a-day plan has advanced to the position where it is paying about eight million dollars yearly for the hospital care of subscribers. Hospital bills amounting to more than sixteen million dollars have been paid since the plan was established five years ago.

With an enrolment of more than 1,350,000 persons, or one out of six in the New York area, the Associated Hospital Service is the largest of sixty non-profit hospital plans throughout the United States. The number

of subscribers increased more than a quarter of a million during 1939. The financial condition as of December 31, 1939, determined by the New York State Department of Insurance shows that a surplus of $1,651,249 is available for the added protection of subscribers.

The annual certificate of approval has been awarded by the American Hospital Association for evidence of progress, sound administrative policies and procedures and a financial position which protects the interests of subscribers.

As experience in the field has increased, adjustments have been made in the service, which has had the continued cooperation of subscribers, of more than 270 member hospitals and of the medical profession. The report closes with the statement that "The American people have found a way to protect themselves against the costs of hospital care for unexpected sickness or accident. The future of non-profit hospitalization throughout the nation is bright with possibilities for even greater service."

THE THEFT OF RESEARCH MICROSCOPES FROM THE BIOLOGICAL LABORATORY, AMHERST COLLEGE

EARLY in the evening of February 5, two valuable research microscopes were stolen from the Biological Laboratory at Amherst College. One of these was the microscope used by Professor Oscar Schotté. It was taken from his laboratory table. It was a Leitz monobjective binocular. Maker's No. 300473, Amherst College No. die cut on base A C BIOL 53. This instrument was equipped with 4 Leitz apochromat objectives and paired 8x oculars. In addition there was attached to it a Zeiss pancratic condenser for illuminating.

The other microscope was a Zeiss machine being used by Dr. George Child in Professor H. H. Plough's laboratory. Maker's No. 259779, Amherst College No. die cut on base A C BIOL 61. This machine was equipped with a Butukni binocular draw tube, two achromat and one apochromat objectives and paired 10x oculars.

A Spencer rotary microtome Maker's No. 3631, Amherst College No. die cut on base A C BIOL 207, was taken from Dr. Schotté's room at the same time as the microscope.

The instruments were in use up to six o'clock on that day, but their disappearance was not noted until the following day. The laboratory building is ordinarily locked after six o'clock, but because of an evening lecture it was open on that particular evening. Apparently neither of the research rooms was locked, although the door of each was closed. Whoever took the instruments knew what he wanted, since other valuable apparatus, including less valuable microscopes and a calculating machine, were passed over without being disturbed.

The Department of Biology of Amherst College will appreciate any information concerning instruments that are offered for sale that will lead to the recovery of the stolen instruments.

OFFICERS OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE Federation of American Societies for Experimental Biology which is made up of the American Physiological Society, The American Society of Biological Chemists, The American Society for Pharmacology and Experimental Therapeutics and the American Society for Experimental Pathology met at New Orleans on March 13, 14, 15 and 16. Officers elected for the coming year are:

The American Physiological Society: Dr. A. C. Ivy, of Northwestern University, *president;* Dr. Philip Bard, the Johns Hopkins University, *secretary;* Dr. C. J. Wiggers, Western Reserve University, *treasurer,* and Dr. Charles H. Best, University of Toronto, *councillor.*

The American Society of Biological Chemists: Dr. W. C. Rose, University of Illinois, *president;* Dr. R. J. Anderson, Yale University, *vice-president;* Dr. C. G. King, University of Pittsburgh, *secretary;* Dr. A. Baird Hastings, Harvard, *treasurer;* Dr. Edward A. Doisy, St. Louis University, *councillor;* Dr. Henry A. Mattill, University of Iowa, and Dr. Glenn Cullen, University of Cincinnati, *council members.*

The American Society for Pharmacology and Experimental Therapeutics: Dr. E. M. K. Geiling, University of Chicago, *president;* Dr. C. F. Schmidt, University of Pennsylvania, *vice-president;* Dr. G. P. Grabfield, Harvard University, *secretary;* Dr. E. E. Nelson, Tulane University, *treasurer;* Dr. B. H. Robbins, Vanderbilt University, and Dr. C. H. Thienes, University of Southern California, *councillors,* and Dr. H. Gold, *membership committee.*

The American Society for Experimental Pathology: Dr. Shields Warren, of Harvard University, *president;* Dr. Jesse Bollman, of Mayo Clinic, Rochester, Minn., *vice-president;* Dr. Harry P. Smith, University of Iowa, *secretary-treasurer,* and Dr. Paul R. Cannon, University of Chicago, and Dr. Balduin Lucké, University of Pennsylvania, *members of the council.*

Dr. Warren, under the plan of having the heads of the constituent groups serve as chairman of the federation in rotation, assumed that office.

SCIENTIFIC NOTES AND NEWS

DR. FREDERIC JOLIOT and Madame Irene Joliot-Curie, co-workers in the Radium Institute, Paris, have been awarded the 1940 Barnard Gold Medal for "Meritorious Service to Science" bestowed by Columbia University every five years. The medal was established by the will of Frederick A. P. Barnard, presi-

dent of Columbia from 1864 to 1889, and is awarded "to the person, if any, whether a citizen of the United States or any other country, who within the five years next preceding has made such discovery in physical or astronomical science, or such novel application of science to purposes beneficial to the human race, as in the judgment of the National Academy of Sciences of the United States is esteemed most worthy of such honor."

PRECEDING the Founders Day Convocation of the Case School of Applied Science on March 10 a dinner was given in honor of Dr. and Mrs. Dayton C. Miller, in recognition of Dr. Miller's fifty years of service to the college. Frank A. Quail, president of the Board of Trustees, presided and introduced Dr. J. J. Nassau, professor of astronomy and director of the Warner and Swasey Observatory, and Dr. W. R. Veazey, formerly professor of chemistry, who paid personal tributes to Dr. Miller. Dr. Philip M. Morse, professor of physics at the Massachusetts Institute of Technology, a former student of Dr. Miller, who was associated with him in the ether drift investigations, also spoke at the dinner. An oil portrait, painted by the Cleveland artist, Rolf Stoll, and subscribed to by a group of alumni, faculty and friends, was presented to the college at the convocation. Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, was the convocation speaker. His address was entitled "Science and Human Happiness." The convocation was held in commemoration of the sixtieth anniversary of the founding of the college, which was the first engineering college established west of the Allegheny Mountains.

DR. FRANK N. FREEMAN, dean of the School of Education of the University of California, previously professor of educational psychology at the University of Chicago, was given a citation for "an outstanding contribution to educational research" on the occasion of the banquet on February 26 at the meeting in St. Louis of the American Educational Research Association. The citation was in recognition of his book on "Twins, a Study in Heredity and Environment."

ACCORDING to the *Journal* of the American Medical Association, Dr. Max Cutler, director of the Chicago Tumor Institute, will be honored at an all-day meeting on March 29, in Atlanta, Ga., on the cure and control of cancer. The sessions will be under the sponsorship of the State Department of Health, the Cancer Commission of the Medical Association of Georgia and the Georgia Division of the Women's Field Army of the American Society for the Control of Cancer. In the evening Dr. Cutler will be presented with an official citation by Governor Rivers in recognition of his "outstanding achievement in the realm of cancer cure and control." At the same time he will be appointed an honorary lieutenant colonel on the military staff of the governor.

THE degree of doctor of science will be conferred at the eighty-seventh commencement of the University of Wisconsin on Dr. Herbert S. Gasser, director of the Rockefeller Institute for Medical Research, New York City.

THE University of Oxford will confer the degree of doctor of science on Dr. E. V. Appleton, secretary of the Department of Scientific and Industrial Research, previously Wheatstone professor of physics at King's College, London, and Jacksonian professor of natural philosophy in the University of Cambridge.

DR. W. H. SEBRELL, of the National Institute of Health of the U. S. Public Health Service, and Dr. J. C. Keresztesy, Joseph R. Stevens, Stanton A. Harris, Eric T. Stiller and Karl Folkers, of the research laboratories of Merck and Company, were awarded jointly at the New Orleans meeting of the American Institute of Nutrition the prize of $1,000 of Mead Johnson and Company—the first for his work on riboflavin and keratitis and the others for the synthesis of pantothenic acid.

DR. DOUGLAS JOHNSON, professor of physiography at Columbia University, has been elected to honorary membership in the Société Royale Belge de Géographie, "in recognition of great services rendered to the geographic sciences."

THE student yearbook for 1940 of the Massachusetts State College will be dedicated to Dr. Charles P. Alexander, head of the department of entomology.

DR. SMITH ELY JELLIFFE, consulting neurologist, New York City, has been made an honorary member of the Dutch Society of Psychiatry and Neurology.

WILLIAM HENRY BRADSHAW, director of rayon research of E. I. du Pont de Nemours and Company, Buffalo, N. Y., has been awarded the Jacob F. Schoellkopf Gold Medal for 1940 of the Western New York Section of the American Chemical Society, in recognition of "distinguished chemical achievement which has resulted in the commercial production of cordura, a high-strength viscose yarn used extensively in the manufacture of automobile tires."

DR. JOHN W. M. BUNKER, professor of biochemistry and physiology and director of the research laboratories of biology at the Massachusetts Institute of Technology, has been appointed dean of the Graduate School. Dr. Bunker will succeed Dr. Harry M. Goodwin, since 1932 professor of physics and electrochemistry, who will retire in June after serving for fifty years on the staff of the institute.

NATHANIEL MCL. SAGE, placement officer of the Massachusetts Institute of Technology, has been ap-

pointed director of the Division of Industrial Cooperation, of which he has been acting head since the death last September of Professor Charles L. Norton, who for many years had charge of research services in the solution of industrial problems. Mr. Sage will continue as placement officer.

THE medical and technical divisions of Sharp and Dohme have been merged under the direction of Dr. William A. Feirer.

THE Parliamentary by-election at the University of Cambridge has been won by Dr. Archibald V. Hill (Independent Unionist), Foulerton research professor and secretary of the Royal Society, with a majority of 4,454. The figures as announced on February 24 were: Dr. Hill, 9,840, and Dr. John A. Ryle (Independent Progressive), professor of physic at the University of Cambridge, 5,386. Of the electorate of 56,286, 41.9 per cent. voted.

IT is announced in *Nature* that, at the request of Sir Walter Monckton, director-general of the Press and Censorship Bureau, Sir William Bragg, as president of the Royal Society, has undertaken the formation of a scientific panel to assist the bureau in arranging the censorship of papers in scientific journals. The following have agreed to serve on the panel: Professor C. R. Harington (biochemistry), Professor V. H. Blackman (botany and agriculture), Professor A. C. Egerton (chemistry), Dr. H. L. Guy (engineering sciences), Professor P. G. H. Boswell (geology), Professor S. Chapman (mathematics), Dr. C. H. Desch (metallurgy), Dr. C. G. Darwin (physics), Professor A. V. Hill (physiology), Professor F. C. Bartlett (psychology), Professor W. W. C. Topley (bacteriology and pathology), Professor M. Greenwood (statistics), Sir Guy Marshall (zoology).

OFFICERS of the Sigma Xi Club of Ohio University at Athens for the present academic year are: *President,* Darrell B. Green; *Vice-president,* Clarence L. Dow; *Secretary-Treasurer,* Amos C. Anderson. Meetings are held every two months, with papers by two members presented at each meeting. Dr. K. K. Darrow, physicist with the Bell Telephone Laboratories, New York, is expected to speak at the annual dinner and to give the annual Sigma Xi lecture at a university convocation.

PROFESSOR GEORGE DAVID BIRKHOFF, of Harvard University, delivered public lectures on March 6, 7 and 8 at the Rice Institute, Houston, Texas, the subjects of which were: "A Mathematical Approach to Ethics," "The Principle of Sufficient Reason" and "Rectilinear Drawing."

AFTER the annual meeting on March 15 for the initiation of new members of the Wesleyan chapter of the Society of the Sigma Xi a banquet was held at which the speaker was Dr. Albert F. Blakeslee, Wesleyan '96, director of the department of genetics at the Cold Spring Harbor Laboratory of the Carnegie Institution, president of the American Association for the Advancement of Science. A series of tests or experiments was given to demonstrate how different people differ in their capacities for taste and smell. In his address at the close of the dinner the importance of the facts demonstrated was discussed.

THE Joseph Henry lecture of the Philosophical Society of Washington was delivered on March 16 by Dr. Harold C. Urey, professor of chemistry of Columbia University. The title of the lecture was "Differences in Physical Properties of Isotopic Substances and the Separation of Isotopes."

DR. ROY CHAPMAN ANDREWS, director of the American Museum of Natural History, will deliver an illustrated lecture on "Hidden Secrets of the Gobi" on the evening of April 2 at a meeting of the Phi Beta Kappa Alumnae in New York.

DR. EDWARD SAMPSON, associate professor and head of the department of geology at Princeton University, addressed the Philadelphia Geological Society at a meeting held at the Academy of Natural Sciences on the evening of March 21. He spoke on "Mineral Resources in Peace and War."

THE twenty-fourth Guthrie Lecture of the British Physical Society was given by Dr. P. M. S. Blackett, professor of physics in the University of Manchester, at the Royal Institution on February 26. The subject of the lecture was "Cosmic Rays: Recent Developments."

APPLICATIONS must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than April 8 for the position of associate entomologist (taxonomy) to fill the position of assistant curator of the National Museum, Smithsonian Institution, at a salary of $3,200 a year, and for the position of assistant entomologist (taxonomy) in the Bureau of Entomology and Plant Quarantine, Department of Agriculture, at a salary of $2,600 a year.

DURING the national meeting of the American Association for the Advancement of Science, which will be held in Seattle from June 17 to 22, there will be an opportunity for those interested in various phases of oceanography to visit the Oceanographic Laboratories at Friday Harbor. Arrangements should be completed prior to arriving in Seattle because instruction and research in all departments begins on June 24 and housing facilities at Friday Harbor are limited.

IT is announced in the London *Times* that the British Association for the Advancement of Science is arranging a conference on science in its national and inter-

national aspects. The conference, which will be held at Reading on July 24, 25 and 26, will take the place of the ordinary annual meeting, which would in normal circumstances have been held at Newcastle.

THE second International Congress of Eugenics has been postponed indefinitely. Further information can be obtained from the general secretary, Professor G. Constantinesco, director of the National Zootechnical Institute, Strada Dr. Staicovici 63, Bucarest.

THE New York State Section of the American Physical Society will hold its spring meeting at the University of Buffalo on April 6. The address of welcome will be made by Dr. S. P. Capen, chancellor of the university. In addition to the program of technical papers, Professor H. A. Bethe, of Cornell University, will give the Foster lecture on Friday evening, April 5. He will speak on "The Theory of Stellar Energy." The lecture will be preceded by a buffet supper.

THE Association of Southeastern Biologists, of which Professor H. L. Blomquist, of Duke University, is president, will meet on April 19 and 20 in Nashville, Tenn., with Vanderbilt University as the host institution. Titles of papers to be presented should be filed with Donald C. Boughton, secretary-treasurer, Regional Laboratory, U. S. Department of Agriculture, Auburn, Ala.

THE annual joint meeting of the Institute of Radio Engineers and the American Section of the International Scientific Radio Union will be held in Washington, D. C., on Friday, April 26. This meeting will be held in the building of the National Academy of Sciences.

THE sixty-ninth annual meeting of the American Public Health Association will be held in Detroit, Michigan, from October 8 to 11, with the Book-Cadillac Hotel as headquarters. The Michigan Public Health Association, the American School Health Association, the International Society of Medical Health Officers, the Association of Women in Public Health and a number of other allied and related organizations will meet in conjunction with the association. Dr. Reginald M. Atwater is executive secretary of the association, with offices at 50 West 50th Street, New York City.

ON Wednesday, March 6, the inaugural Ephraim McDowell Lectureship of the University of Louisville School of Medicine was presented in the amphitheater of the Louisville City Hospital. The meeting was opened by Dr. John W. Moore, dean of the medical school. Dr. Irvin Abell, who is an authority on the life of Ephraim McDowell, gave a résumé of the life and work of the great Kentucky pioneer surgeon. Dr. M. Herbert Barker, of Northwestern University Medical School, delivered the inaugural lecture. He was introduced by Dr. J. Murray Kinsman, of the University of Louisville. Dr. Barker's subject was "Modern Pioneers in Vascular Diseases." The McDowell lectures are being sponsored annually by the Phi Beta Pi Medical Fraternity.

DISCUSSION

CHANGES IN MODERN MATHEMATICS

IN 1898 there appeared the first part of a large mathematical encyclopedia entitled "Encyklopädie der Mathematischen Wissenschaften," which was due to international cooperation and was completed in 1935. Even before it was completed it was commonly recognized that at least the first one of the six volumes was already out of date and in need of many fundamental changes in order to be abreast with current scholarship along its line. This rapid obsolescence may be contrasted with the fact that certain parts of Euclid's "Elements" were used as text-books more than two thousand years after they were written and are still regarded as masterpieces. Since the summer of 1939 several parts of a revised volume 1 of this mathematical encyclopedia have been published, and it is interesting to see how profoundly these parts, relating to algebra and the theory of numbers, differ from the corresponding parts of the first edition.

In particular, much more space is devoted to the theory of groups and its applications in this revised edition than in the first edition. While only about 18 pages were devoted to finite discrete groups in this first edition, 51 pages are devoted to only a part of this subject under the heading of general group theory in this revised edition. It is especially interesting to note that the subject of general or abstract groups precedes that of permutation groups in this edition, while the reverse method was followed in the first edition. These two subjects supplement each other, and it would not be profitable to try to determine their relative importance even if the former is more widely useful. The subject of group theory was, however, first studied in connection with permutation or substitution groups. The fact that abstract groups permeate the treatment of various other subjects in this revised edition is especially noteworthy.

What may be of most interest to the non-mathematician in connection with this revised edition is the fact that some of the modern mathematics relating to

elementary subjects has so quickly become out of date. In the "Encyclopaedia Britannica" (1938) it is stated under the entry "Number" that "the concept of ordinary number was first adequately presented by Euclid." The treatment of the development of number systems and the representation of real numbers by limiting processes in the parts of this revised volume which have appeared indicate wide digressions from Euclid in the modern development of concept of ordinary or positive numbers. The fact that the ancient Greeks commonly restricted the notion of number to discontinuous magnitudes is of fundamental importance in the history of mathematics and must be clearly understood in order to evaluate the contributions made by recent mathematicians towards our present concept of number.

The revised volume to which we referred above enables the German mathematicians to retain now the leading position among the mathematicians of the world with respect to mathematical encyclopedias, even if it omits a number of the important subjects, including the theory of probability, which were treated in the first edition. It also includes some subjects, such as mathematical logic, which were not explicitly treated in the first edition but constitute a welcome addition in this revised volume. The number of references is large, but in view of the great extent of the recent literature they do not aim to be complete. A wise selection of references is very useful to the beginner in a field of mathematical study in these days of intense specialization when too little is frequently left to be supplied by the reader who enjoys to supply the obvious.

Recently the American mathematicians started a periodical under the title of *Mathematical Reviews,* which may bring to our country an important share of the reviewing of the current mathematical literature of the world and thus arouse a greater interest in the mathematical advances of the present time. Heretofore the German mathematicians have been especially prominent along this line. They established in 1871 a review journal entitled *Jahrbuch über die Fortschritte der Mathematik,* which has been published fairly regularly since then and is widely used wherever mathematical advances are successfully made in a rapidly widening list of countries. In 1931 they established a second somewhat similar periodical under the title *Zentralblatt für Mathematik* with a view to bringing reviews to the attention of the public more promptly than was done earlier. The recent American periodical along this line will therefore have considerable competition, but it has started out in a promising manner and will probably receive strong support, especially in America.

G. A. MILLER

UNIVERSITY OF ILLINOIS

THE CHESTNUT BLIGHT AND ITS RELATION TO THE PRINCIPLE OF DISEASE RESISTANCE

CADMUS' adventure with the slain dragon's teeth that sprang anew into life forms an allegory of the American chestnut, *Castanea dentata* Borkh. Consigned to rapid extermination and a place with the dodo as an extinct species after discovery of the disease in the Bronx in 1904, the chestnut perennially springs into life and is still a familiar species of our woodlands, its foliage adding to the lower-story canopy of the summer forest and its wood and bark providing a habitat for associated species.

Data collected on survival of the American chestnut were published in this journal[1] some years ago, and private research again makes possible a picture of the present blight situation. Permanent plots were laid out in the earlier days of the research, carefully charted and each tree measured, the increase in length of every stem and twig of each tree for each growing season being recorded as cm increment of growth. The lengths of stem and twig killed by blight the same year were recorded in like manner. It was found in 1926, when the last report was published in SCIENCE, that the ratio of new growth produced to blight-killing in the year 1926 was as 3 to 1. The plots have been remeasured in 1939 and the ratio, while varying widely with soil and plot history, is again favorable, the average for all plots tallied being better than 2 to 1. As the trees grow older the total volume of increment naturally increases: thus, Table 1 shows the growth increment for one plot.

TABLE 1

TOTAL GROWTH INCREMENT FOR PLOT 3, EXPRESSED IN TERMS OF CM LENGTH EXTENSION OF TWIG AND SHOOT

1926—1,431 cm	1929—4,456 cm
1927—1,812 cm	1930—5,681 cm
1928—3,092 cm	1939—8,092 cm

Our study has brought to light several noteworthy facts. First, stump sprouts have very little resistance to blight, and the rapid destruction of their coppice has doubtless led to the popular belief that the chestnut is being exterminated. On the other hand, seedlings have proved highly resistant, and many of the seedlings on our plots have come through the fifteen years of our observational study untouched or but slightly touched with blight. Moreover, several new seedlings have appeared on our plots and have reached a height of from 1 to 3 m in the period of our study. The seed trees earlier recorded in SCIENCE are still fruiting and are apparently responsible for at least one healthy seedling that appeared in Plot 2. There are several enemies of the seedlings, however, which now appear almost as inimical as the *Endothia:* Hunters do a sur-

[1] SCIENCE, 60: 292–293, 1924; *ibid.,* 63: 476–477, 1926; *ibid.,* 70: 538, 1929.

prising amount of damage by inflicting gunshot wounds on saplings. A number of our seedlings bore such wounds and in some cases blight had evidently entered through the wound. Rabbits are very destructive to small sprouts and tender shoots which they shear off. Our Plot 4 had been browsed by deer. Plot 5 had suffered from fire, while Plots 1 to 4 had been ravaged by man. But chiefest enemy of chestnut is shading, for seedlings endure shade only with difficulty, while stump sprouts quickly dwindle and disappear. The best thing that can now be done for chestnut is to give it a careful release cutting; and wherever this has been done the chestnut shoots into rapid and healthy growth.

The question now arose as to why vigorous seedlings should be resistant to blight and why sometimes the chestnut is able to heal the cankers and continue living. It occurred to the writer that the chestnut canker might be comparable to the fungus-root or mycorrhiza. In both cases a higher plant is attacked by a fungus and in both the higher plant can resist the fungus. In the mycorrhiza the fungus penetrates to a certain distance within the root tissues, then coils, forms twig-like or spore-like structures, breaks down and is evidently absorbed by the root-cell with accompanying increase in size and stainability of the host nucleus. The writer collected diseased and healed cankers of the chestnut, sectioned them and studied them under the microscope. The diseased cankers were found to contain abundant mycelium penetrating freely through the tissues. The healed cankers, on the contrary, showed limitation of the fungus and there were all stages in the breaking down of the fungus with formation of typical "digestion cells" and enlarged host nuclei exactly as in the mycorrhiza. Apparently the resistance of the root to the fungus which results in a swollen mycodomatious organ is exactly the same sort of thing as the resistance of the chestnut stem which results in a swollen fungus-digesting knot on the stem.

We were next interested in the question of how the host limits the fungus. Why are some cankers healed while others are lethal? The problem again appears paralleled by the mycorrhiza: We know that the mycorrhiza is an organ of "mutualistic symbiosis" only when the host is growing vigorously, but that the fungus may become a parasite if the host's vigor is lessened. We know, moreover, that in any given species the fungus *always penetrates to a given depth* within the host tissues. In some species it penetrates only the epidermis, in others the outer cortex, in still others the mediocortex; but the central cylinder is never invaded and is usually not too closely approached. We know, too, that the central cylinder is the region of "food" transport and from the central cylinder elaborated materials pass outward toward the exterior of the root, being diluted by materials passing inward from the soil. Without having experimental data to support his idea, the writer believes that the osmotic coefficient for sap in the central cylinder is greater than that of the outer tissues of root or stem, and that the osmotic pressures decrease progressively toward the exterior. The writer suggests the following hypothetical picture of the relation of fungus to host as dependent on a balancing of osmotic pressures. As long as the fungus can maintain a higher osmotic pressure than the host sap it encounters, it penetrates into the host tissues; but whenever it encounters a higher osmotic pressure it is broken down and absorbed by the host cell. We know as a fact that this breaking-down process and "phagocytosis" occurs in a definite region in any specific mycorrhiza and we may suppose that it is to that region the elaborated materials have filtered from the central cylinder in sufficient quantity to raise the cortical ionic concentrations enough for them to break down the fungus. The pelotons, arbuscles, sporangioles, etc. of the mycorrhiza would then appear to be simply the pathological developments of hyphae in an unfavorable environment, just as the root hair will form curious knottings, etc. (even breaking down) when placed in an unfavorable ionic concentration. In the chestnut, the resistant canker is one possessing osmotic values great enough to overbalance the fungus. Resistant seedlings are those of healthy vigorous growth with salt-rich sap. Dying stump-sprouts are killed because the root systems are not able to retain their vigor after the tremendous major operation caused by removal of the large tree which formerly supported them.

ARTHUR PIERSON KELLEY

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THE "BABOON BOY" OF SOUTH AFRICA

PERIODICALLY, for more than a decade, the South African as well as European and American presses have carried reports regarding a native South African boy nurtured by baboons. Relatively convincing evidence establishing the authenticity of the case has just become available for the first time, largely due to the offices of Dr. Raymond A. Dart, professor of anatomy at the University of the Witwatersrand, Johannesburg, South Africa, to whom the writer is indebted for a copy of the original documents relating to the case.

The data seem to indicate that the boy was discovered in 1903 by two troopers of the Cape Mounted Police. Coming across a troop of baboons playing in a clearing in a remote part of the South East Cape, they fired into the group, and were surprised to notice that one animal who was not as fast as the others was left behind. The laggard was caught and found to be a native boy between 12 and 14 years of age. The boy

was taken to a mental hospital, where he remained for a year, before being given over to a farmer, for whom he has subsequently worked.

When found, the "baboon boy" showed a rather atypical physical development, as evidenced by his long arms and the abnormal development of the haunches. He jumped about, and showed a strong desire to walk on all fours. He mimicked like a baboon and exhibited other animal-like mannerisms, such as a constant jerking and nodding of the head, the scratching of parts of his body with the index finger and a peculiar and frightened-looking grin. He violently objected to being washed, and had to be thrashed repeatedly for his dirty animal habits in and about the house. He could not speak, but chattered like an ape. He was very mischievous and wild and "full of monkey tricks." Although offered the best fare, he retained his old taste in food and preferred a meal of raw corn and cactus, once consuming as many as 89 prickly pears. He took no account of time, and always had to be called to do a particular task.

The "baboon boy" of South Africa thus represents an addition to the list of reasonably authenticated cases of human infants who have grown up under unusual stimulational circumstances, without access to human culture. This appears to be the first case of a human child adopted and reared by infrahuman primates. It is also important to note that although with continued human contacts the boy retained traces of his infrahuman associations, his adaptation to human institutions appears to have been markedly better than that of previously reported wild foundlings, such as the wild boy of Aveyron and the "wolf children" of India. The "baboon boy" became a dependable worker, was reported to be "remarkably intelligent" and developed the use of language, by which he was able to relate details of his past life among the baboons.

A more detailed and fully documented report of this interesting case will appear in the forthcoming issue of the *American Journal of Psychology*.

JOHN P. FOLEY, JR.
THE GEORGE WASHINGTON UNIVERSITY

A CORRECTION

IN a recently published volume on "The Origin of Submarine Canyons" the writer inadvertently credited to A. C. Veatch an excerpt from a submarine chart actually contoured by P. A. Smith, of the U. S. Coast and Geodetic Survey. The chart in question is Chart IVB of Special Paper No. 7 of the Geological Society of America entitled "Atlantic Submarine Valleys of the United States and the Congo Submarine Valley, by A. C. Veatch and P. A. Smith," and the excerpt appears as Plate III of the volume first cited above. In view of the heavy labor involved in contouring the charts accompanying the paper by Veatch and Smith and the beauty of the finished product, it would be unfair to Mr. Smith to permit the error to go uncorrected. Excerpts from two other charts are correctly ascribed to Dr. Veatch.

DOUGLAS JOHNSON

UNUSUAL EASTER DATES

THE very early and the very late Gregorian Easter dates are given in the following table; it covers more than eight centuries, from the Gregorian calendar reform (1582) to the end of the XXIVth century. The table shows that the most unusual Gregorian Easter date is March 24; it occurs, in 1940, for the second time since the Gregorian reform; if another calendar reform should occur during the next 450 years, the Gregorian Easter Sunday of 1940 will be the last one to fall on March 24.

GREGORIAN EASTER DATES

March 22	March 23	March 24	April 24	April 25
1598				
1693	1636		1639	1666
1761	1704		1707	
	1788	1799	1791	
1818	1845		1859	
	1856			1886
	1913	1940		1943
	2008		2011	2038
			2095	
	2160		2163	2190
2285	2228		2231	2258
	2380	2391	2383	2326

ALEXANDER POGO
CARNEGIE INSTITUTION OF WASHINGTON

SCIENTIFIC BOOKS

LAND MOLLUSCA OF NORTH AMERICA

Land Mollusca of North America (North of Mexico). Vol. 1, Part 1. By HENRY A. PILSBRY.[1]

IN 1837 Amos Binney began the publication of his "Monograph of the Helices Inhabiting the United States.[2] In 1851–57 Binney published "The Terrestrial Air-breathing Mollusks of the United States," Volumes 1–3 (these volumes were edited by Gould). At the death of Amos Binney, his son, W. G. Binney,

[1] 1939. Monograph No. 3, The Academy of Natural Sciences of Philadelphia, pp. xvii + 573, index, ix pp., 377 text illustrations, more than 2,000 figures. $7.50 to subscribers of complete set; separate, $10.00.

[2] *Jour. Boston Soc. Nat. Hist.*, 1: 466–495, pls. 12–19; 3: 353–438, pls. 7–26.

ok up this work, publishing a fourth volume in 1859 d a fifth in 1878, and supplements 1, 1883; 2, 1886; 1890, and 4 in 1892. In 1865, W. G. Binney, in llaboration with Bland, published in the Smithnian Miscellaneous Collections, No. 194, "Land and resh-water Shells of North America." As his major deavor, however, we may consider "A Manual of orth American Land Shells," Bulletin No. 28 of the nited States National Museum. This volume has rved most students of Mollusca as a basis for their udies.

The endeavors of the Binneys may be considered as aving had a two-fold purpose: First, they brought gether in a convenient compass the work of the ioneer malacologists scattered through the scientific terature at home and abroad, and, second, by the e of anatomic material to produce a clearer underanding of the relationship of the known forms. The ork of the Binneys definitely closed the pioneer days, nd the 1885 production we may well say constituted e beginning of the present era in American malacolgy. Since that time much work has been done, but no summary monograph bringing our knowledge of the subject under a single cover has been produced. This is the intent of the present undertaking.

We feel justified in copying the table of contents of the present volume since this will fully explain the ground covered by Dr. Pilsbry. We are adding to this a column showing the number of named forms cited in Binney's "Manual" and the number of species and subspecies now recognized by Dr. Pilsbry, as well as two additional columns showing the number of species and subspecies in each subgenus, of which Dr. Pilsbry is author or co-author. The fact that he has described 66 out of the 188 known species and 97 out of the 210 subspecies here treated, gives ample reason why his, and his only, should be the master hand to produce this volume.

Dr. Pilsbry has displayed good judgment in his definition of species and subspecies, and especially in relegating names that seem to have been bestowed upon phases of variation found within the same population under the designation of form, instead of using a trinomial. He has done this without being partial, even to himself!

The various categories are ably defined and adequate bibliographic references are furnished. The distribution of the various groups in time and space is discussed, and with each species and subspecies its distribution, as well as the source of material upon which his contentions are based, is mentioned and where possible the collector's name is appended. Variations within the subspecies are described and where names have been bestowed upon such by previous writers, these are mentioned and discussed.

The enormous amount of anatomic detail produced by the author as displayed in the illustrations and text puts on a firm basis the classification adopted, and easily makes understandable the present concept and its variation from the Binneyan picture.

Malacology to-day, as far as the taxonomic phase thereof is concerned, is in an even worse condition than it was in 1885. Amateurs and young students have, as a rule, no access to the tremendous scattered literature nor to the needed comparative material, unless they happen to be at the few centers where such is available, to decide properly what the status of things they may gather may be. With such a splendidly illustrated basic volume it will be easily possible for them to get a complete vision of the field. We feel sure that this new platform which Dr. Pilsbry is building will reawaken the interest that this group of organisms—unique as a tool in the field of ecology, genetics and zoogeography—deserves.

We understand Part 2 is completed and we hope that Volume 2 is well under way.

PAUL BARTSCH

U. S. NATIONAL MUSEUM.

	Species older than 1885	Species	Subspecies	Pilsbry's species	Pilsbry's subspecies
mily I. HELICIDAE					
Genus Helix					
Subgenus Helix, s.s.					
Subgenus Cryptomphalus	1	1			
Genus Cepaea	2	2			
Genus Otala					
Genus Helicigona					
Genus Theba	1	1			
mily II. HELICELLIDAE					
Genus Hygromia					
Subgenus Trichia	2	2			
Genus Monacha	1	1			
Genus Helicella					
Subgenus Trochoidea	1	1			
Genus Cochlicella	1	1			
mily III. HELMINTHOGLYPTIDAE					
subfamily Cepoliinae					
Genus Cepolis					
Subgenus Hemitrochus	1	1			
subfamily Helminthoglyptinae					
Genus Monadenia	6	7	14		4
Genus Helminthoglypta					
Subgenus Helminthoglypta s.s.	14	33	38	3	9
Subgenus Charodotes	2	12	17	1	3
Genus Micrarionta					
Subgenus Micrarionta s.s.	3	5	2		
Subgenus Eremarionta		21	22	1	4
Subgenus Xerarionta	4	4	2		
Subgenus Plesarionta	1	1			
subfamily Sonorellinae					
Genus Sonorella					
Subgenus Sonorella s.s.		44	38	35	35
Subgenus Masculus		6	2	6	2
Subgenus Sonoranax		1			
Subgenus Myotophallus		1			
subfamily Humboldtianinae					
Genus Humboldtiana		6	1	5	1
mily IV. CAMAENIDAE					
subfamily Oreohelicinae					
Genus Oreohelix					
Subgenus Oreohelix s.s.	9	27	61	11	28
Subgenus Radiocentrum		5	10	4	10
subfamily Ammonitellinae					
Genus Polygyrella	1	1			
Genus Ammonitella	1	1			
Genus Polygyroidea	1	1			
Genus Glyptostoma	1	2	3		1
	53	188	210	66	97

BIOLOGICAL OXIDATION

Biological Oxidation. By CARL OPPENHEIMER and KURT G. STERN, with the collaboration of W. ROMAN. 276 pp. Bibliography of 1,383 references. The Hague: Dr. W. JUNK. New York: Nordemann Publishing Co., Inc.

THIS book is an entirely revised edition of one particular section of the senior author's (O.) comprehensive book, "The Ferments and Their Effects," which has been for several decades the guiding comprehensive work on enzymes. At a time when the knowledge about enzymes seemed to have just reached a level such as to justify the writing of a special section on enzymes in the frame of a text-book of biochemistry, Oppenheimer published the first edition of the book and brought it up to date in five successive editions. In this book the author not only organized the ever-increasing material but also largely contributed to the establishment of fundamental concepts and nomenclature of which a great deal is now in common use. A supplement to the fifth edition of this book, published in 1937, is the basis of the present book. It has been revised and supplemented by Kurt G. Stern, who not only has contributed a creditable amount of valuable experimental work in this field but also has shown on several occasions his ability in writing well-organized reviews. He is especially responsible for the chapters on redox potentials in heterogeneous systems; affinity and rate of reactions; the semi-quinones as intermediate steps of oxidation; photochemistry of the respiratory enzymes, yellow enzymes, carboxylase, protein bearers of enzymes and other topics of the most recent origin.

The vast material deposited in the ever-increasing amount of literature of the last few years has been exhaustively utilized in this book and organized in a systematic way. The authors are very well conscious of the fact that the present state of the theory and the system of the book derived from it, are just strong enough for the practical purpose of holding the material together, giving every experimental observation its proper place within the book and alleviating the enumeration and discussion of the vast material, yet that this system is not rigid, but flexible according to further discoveries.

The general part (pp. 1–123) is essentially concerned with the theory of oxidation-reduction. Here the contrast between Warburg's theory of activation of oxygen and Wieland's theory of activation of hydrogen, and the reconciliation of the two by the unitarian theory, plays an important role. The special part (pp. 123–275) is essentially descriptive and contains such chapters as "the hemin systems," the "vitazymes," a name by which the authors comprise such enzymes as, for instance, alloxanthin enzymes and ascorbic acid; the "Nucleotide coenzymes and enzymes," the "quinoid mesocatalysts," such as Pyocyanine, Phthiocol.

The last chapter, on "Cell Respiration," is comparatively short (28 pp). It is obviously not considered as the topic proper of the book. Cell respiration, indeed, is the integration of all such individual enzymatic reactions as are dealt with in the preceding sections of the book. The problem of respiration, being a coordinate act of the organism; is a part rather of physiology; the main part of the book, however, consists, as it were, of a dissection of that coherent action of the living cell into the elementary, individual partial chemical reactions each of which requires a special study even without regard as to how it is interwoven with others for the purpose of respiration as a whole.

It may be mentioned that some of the few mathematical formulae occurring in the book, namely, in the chapter on two-step oxidation, are misprinted (p. 103).

The book will be a real help for those working experimentally in the field of cellular oxidation and reduction, and an instructive and comprehensive book for physiologists and biologists in general.

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REPORTS

RADIOACTIVE STANDARDS[1]

A SERIES of radioactive standards are being prepared under the direction of the Committee on Standards of Radioactivity of the National Research Council. These standards will be deposited at the National Bureau of Standards in Washington, D. C., to be issued as working standards to investigators who may desire them.

The standards under preparation at present are:

(1) *Radium Standards:*

(a) 100 cc solutions sealed in 200 cc Pyrex flasks containing 10^{-9} and 10^{-11} grams of radium to be used as emanation standards either directly or by subdilution.

(b) 5 cc solutions sealed in Pyrex ampoules containing, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10, 20, 50 and 100 micrograms of radium to be used as gamma ray standards. If desired, these may be obtained in sets of 13 with two each of the 0.2, 2 and 20 microgram standards.

(2) *Thorium Standards:*

Sealed ampoules containing sublimed ThC

[1] This work is being supported in part by a generous grant from the American Philosophical Society to the Massachusetts Institute of Technology.

These may be used in preparing standard thorium solutions. Directions for use will be furnished with the standards.

3) *Standard Rock Samples:*

The following rocks, ground to pass 40-mesh screen and be retained on 100-mesh screen, are available in 100-gram samples.

Quartzite (Virginia)
Triassic diabase (Virginia)
Milford granite (Massachusetts)
Chelmsford granite (Massachusetts)
Gabbro-diorite (Massachusetts)
Columbia River Basalt (Idaho)
Berea sandstone (Ohio)
Dunite (North Carolina)
Carthage granite (Missouri)
Carthage limestone (Missouri)
Deccan Trap (India)
Kimberlite (South Africa)

These samples of rock will be analyzed for radium d thorium content and are intended for use as work- g standards to check methods used in extraction of don and thoron from rock samples. They may be ed for direct fusion in the electric furnace or for rbonate fusion.

All the above samples will be analyzed at a number laboratories equipped to make such measurements d ultimately certificates will be issued by the Na- nal Bureau of Standards. This work is in progress t will require considerable time for its completion that final figures are available only for a part of e samples at the present time.

Accurate knowledge of the radioactive content of the terials of the earth's crust is of primary importance many phases of geology, geophysics and cosmology. Reliable radioactive standards are also essential in studies of radium and thorium poisoning and in biological and medical investigations using the technique of radioactive indicators or internal artificial radioactivity therapy. For the latter purposes calibrated standard sources of β-rays will be made available.

It is hoped that the standards which have been prepared by the committee will provide all workers in these fields with a common basis for comparison of measurements and also improve the accuracy of all measurements of this type. It is likely that they will have other applications, and the committee would appreciate hearing from interested persons who may desire similar standards for their work. The committee is also glad to cooperate as far as possible in aiding investigators to use these standards to the best advantage and welcomes specific inquiries regarding their use. It is urged that any suggestions regarding other desirable radioactive standards, not at present available, be submitted promptly to the committee. In particular, it will facilitate the work of the committee if those laboratories and individuals which can make use of these standards advise the committee of their probable requirements.

Communications may be addressed to the chairman, Professor Robley D. Evans, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

L. F. CURTISS
CLARK GOODMAN
ALOIS F. KOVARIK
S. C. LIND
C. S. PIGGOT
ROBLEY D. EVANS, *Chairman*

SPECIAL ARTICLES

REVERSIBLE INHIBITION OF TOBACCO MOSAIC VIRUS IN LIVING CELLS WITH 0.0002 MOLAR SODIUM CYANIDE

MOST studies on inactivation of plant viruses have en carried out *in vitro*.[1,2,3,4] Such data have furished valuable information as to reactive groups in rus molecules. Little is known, however, of the posbilities of reversible inactivation of virus mechanisms living cells. Such information should aid in elucidating the substrates and reactions involved in virus ultiplication.

Woods[5] was the first to call attention to the abnormal oxidase and peroxidase content of virus-infected tissues. A further investigation of the relation between certain oxidation catalysts and the virus mechanism has led in part to the work reported here. Detailed studies have shown that protoplasmic streaming in leaf cells of tobacco is *oxygen sensitive*. In a given leaf the rate of streaming can be reversibly and characteristically inhibited by sodium cyanide. A 0.0002 M solution of sodium cyanide is as effective in inhibiting the rate of protoplasmic streaming as is a 0.02 M concentration. These concentrations of cyanide also inhibit the action of tobacco peroxidase and catalase. The inhibiting effect of cyanide on the hemin-containing respiratory catalysts is well known.[6]

It was found that tobacco leaf tissue could be kept alive over 36 hours in 0.0002 M sodium cyanide by

[1] W. M. Stanley, *Phytopath.*, 25: 899–921, 1935.
[2] R. Best, *Annals of Appl. Biol.*, 23: 759–780, 1936.
[3] A. F. Ross and W. M. Stanley, *Proc. Soc. Expt. Biol. Med.* (*N. Y.*), 38: 260–263, 1938.
[4] W. B. Allington, *Phytopath.*, 28: 902–918, 1938.
[5] A. F. Woods, *Centralbl. Bakt. u. Par.*, 5: 745–754, 99.
[6] C. Oppenheimer and K. G. Stern, "Biological Oxidation," The Hague, 1939.

TABLE 1

INFLUENCE OF 0.0002 M SODIUM CYANIDE ON MULTIPLICATION OF TOBACCO MOSAIC VIRUS IN DETACHED HALF LEAVES OF *Nicotiana tabacum*

Experiment	Hours between which cyanide treatments were made (Time of inoculation = 0)	Hours of virus test	Amount[a] of virus CN–treated : control	Per cent. total time in NaCN	Per cent. reduction in virus concentration due to NaCN treatment
1	½ to 15½; 24 to 40; 51 to 64	66	25/93	66.6	73.2
2	10½ to 21½; 36 to 46; 59½ to 70½	76½	762/1263	41.8	39.7
3	48 to 72 (sample A)	74½	535/856	32.2	37.5
	(sample B)	97	817/885	24.7	7.7

[a] Concentration expressed as number of necrotic lesions developed on opposite halves of *N. glutinosa* (or hybrid) leaves.

maintaining a constant flow of solution. When the cyanide-treated tissue was washed with running tap water for several hours complete recovery in the rate of protoplasmic streaming usually resulted. By alternately treating with cyanide and dialyzing with water, tobacco leaves were kept alive for periods of several days. With this information as a background whole leaves were inoculated with a single-lesion strain of severe mottling tobacco mosaic virus, rinsed with tap water and split lengthwise into two halves through the mid-rib. One half of each leaf was immersed in a 0.0002 M sodium cyanide solution and the other half, the control, was immersed at the same time in tap water. A slow flow of solutions was maintained from reservoirs at room temperature, average approximately 25° C. Freedom from death of the cells due to cyanide was determined by the macroscopic and microscopic appearance of the treated tissues. In all the experiments reported here protoplasmic streaming was still active in the leaf cells at the end of the tests. Retardation of virus multiplication can not therefore be attributed to death of cells during treatment with cyanide. All samples were dialyzed with water for several hours to free them of traces of cyanide before inoculation tests. Some of the results obtained are summarized in Table 1.

The data of Table 1 show that 0.0002 M sodium cyanide retards the multiplication of tobacco mosaic virus in living cells. The virus multiplication mechanism either depends on the activity of hemin-containing respiratory catalysts of the cell or the virus protein itself may contain hemin or some similar structural unit that can be blocked reversibly with cyanide.

ments showed that virus multiplication had been resumed. The virus had almost reached the level of concentration in the controls which were apparently nearing the maximum.

Experiments with detached leaves of an F_2 necrotizing hybrid (*Nicotiana tabacum* × *N. glutinosa*) illustrated the reversible inhibition of virus in a very striking manner. Actual virus concentrations were not measured, but the time of appearance of the local necrotic lesions was recorded. Necrotic spots usually appear in detached leaves of this hybrid held in air for 60 to 75 hours after inoculation. Lesions develop in leaves immersed in oxygenated water in about the same time. The data in Table 2 show that 53 hours treatment with 0.0002 M sodium cyanide delayed appearance of lesions 45 hours.

Seventy and one-half hours after inoculation, when the control halves were heavily spotted with lesions 2 to 3 millimeters in diameter, the cyanide-treated tissues showed no symptoms of virus infection. Lesions finally appeared after cyanide treatment had been stopped for 50 hours.

With respect to ability to multiply in living cells, tobacco mosaic virus responds to 0.0002 M sodium cyanide in much the same way that certain hemin-containing catalysts do. This indicates that the virus

TABLE 2

EFFECT OF 0.0002 M NaCN ON TIME OF APPEARANCE OF NECROTIC LESIONS OF TOBACCO MOSAIC VIRUS IN DETACHED LEAF TISSUE

Hours between which cyanide treatments were made (Time of inoculation = 0)	Hours after inoculation	Number necrotic lesions in control tissue	Number necrotic lesions in cyanide-treated tissue
2 to 18½; 25 to 40½; 44½ to 65½	70½	approx. 250	none
Treatment with water after 65½ hours	97½	approx. 250	none
	115½	approx. 250	approx. 250

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FURTHER NOTE ON THE EXISTENCE OF A RESPIRATORY NEUROHORMONE

THIS note is a report on the progress of the study of a respiratory neurohormone described in this journal a few months ago.[1]

The respiratory stimulation in atropinized and in eserinized-atropinized dogs by acetylcholine injections occurs following removal of both adrenal glands at the time of experiment or several weeks prior thereto. Similarly, when the liver and abdominal viscera are excluded from the circulation by mass ligation or by clamping the abdominal aorta at the level of the diaphragm, respiratory stimulation results from injection of acetylcholine into the jugular vein. It follows that substances liberated from the adrenal glands or the liver are not necessary for the elicitation of the respiratory stimulation.

It has been repeatedly suggested that nor-epinephrine is a true sympathin. Various doses of this substance, from amounts producing no rise in blood pressure to amounts producing pressor effects up to 150 mm of Hg, have been injected intravenously. Respiratory stimulation was not observed in any of the animals, but, on the contrary, an epinephrine-like apnoea occurred.

In addition to acetylcholine, other choline derivatives—muscarine (nitrous acid ester of choline); mecholyl (acetyl-beta-methylcholine chloride) and doryl (carbamyl choline chloride)—have been assayed for their respiratory stimulating actions in atropinized animals. Muscarine and doryl in doses of 0.15 to 0.5 mgm per kilogram of body weight produced pressor effects and marked stimulation of respiration. Doryl in doses of 0.25 mgm or more per kilogram, produced after a brief stimulation a secondary depression of respiration, as judged by the ineffectiveness of acetylcholine in producing respiratory stimulation during this period. The pressor effect of acetylcholine is not abolished by doryl, but respiratory depression lasts for about twenty minutes. Recovery is gradual. Mecholyl, except in very large doses (2.0 mgm or more), does not produce respiratory stimulation. Atropine does not completely block the vasodilator effect of mecholyl, and because of this, in several animals mecholyl produced a stimulation of respiration due to fall of blood pressure. When this fall was prevented or diminished by the administration of additional atropine, no respiratory stimulation occurred following injections of 0.1 to 2.0 mgm of mecholyl. These experiments show that only choline derivatives with a nicotine-like, *i.e.*, ganglionic stimulant action, possess the property of respiratory stimulation, and that the choline group in itself is not the causative agent.

Nicotine, a ganglionic depressant in large doses, abolishes the respiratory stimulation not only of acetylcholine but also of doryl and muscarine. Ergotamine, which abolishes or reverses the pressor effect of acetylcholine in atropinized animals but does not interfere with the liberation of sympathin as a result of nerve stimulation, does not abolish the respiratory stimulating effect of acetylcholine.

We have already reported on the comparison of the effects of acetylcholine injections into the femoral vein and into the common carotid artery. Repetition of these experiments confirmed the previous observation that acetylcholine chloride, an acid salt, injected into the common carotid artery stimulates respiration in an occasional animal after a latent period of three to seven seconds. Recognizing the possibility of a direct stimulation of the chemoreceptors by the acetylcholine solution, we wish to emphasize that this stimulation is not identical with, and can be differentiated from, the panting response seen following intravenous injection of effective doses of acetylcholine. If effective doses of acetylcholine (0.3 to 1.0 mgm per kgm) are injected into atropinized animals via the common carotid artery one may observe: (*a*) A slight acceleration of respiration about five seconds after injection, and, (*b*) the usual panting response about fifteen seconds later. This sequence is interpreted to mean that the first phase is due either to direct stimulation of the chemoreceptors or to the elaboration of sympathins in the head region, and the second phase to liberation of sympathins following general ganglionic stimulation.

In nine pairs of dogs the attempt was made to transfer this hypothetical respiratory stimulant, by transfusion, from one to the other; the donor receiving atropine and eserine, and some of the recipients atropine. At the beginning of the respiratory response following acetylcholine injection into the donor, from 20 to 30 cc of its blood was rapidly removed from the carotid artery and immediately injected into the femoral vein of the recipient. In five recipients there was no stimulation of respiration following transfusion; in three animals there was a slight respiratory stimulation, and in one there was a marked stimulation of respiration.

Heymans *et al.*,[2] found an immediate and evanescent respiratory stimulation following intracarotid injections of 0.006 to 0.012 mgm of acetylcholine per kgm. We did not observe this phenomenon in all animals. Anitschkow[3] reported that several ganglionic stimulants produced reflex stimulation of respiration by way of chemoreceptors in the carotid body; following transient stimulation these stimulants depressed or paralyzed the chemoreceptors. Anitschkow believes that the chemoreceptors, the cells of the glomus caro-

[1] Koppanyi and Linegar, SCIENCE, 90: 141, 1939.

[2] Heymans, Bouckaert, Farber and Hsu, *Arch. Int. Pharmacodyn.*, 54: 129, 1936.

[3] Anitschkow; *Ibid.*, 55: 61, 1937.

ticum, are the equivalents of sympathetic ganglia or chromaffin cells. If so, it is not surprising that acetylcholine and other ganglionic stimulants excite these structures directly. Dautreband and Maréchal[4] and Wispelaere[5] studied the respiratory stimulating action of various choline derivatives. Wispelaere apparently errs in his statement that mecholyl is a respiratory stimulant, since his tracings reveal that the slight respiratory stimulation which he obtained is due to the steep fall of blood pressure.

We say, in conclusion, that we have shown the existence of a neurohormonal mechanism involving the excitation of the chemoreceptors in the carotid sinus region which, in turn, causes reflex stimulation of respiration. This is a mechanism which may be involved in respiratory stimulation not dependent upon increase in the alveolar carbon dioxide pressure or increase of fixed acids in the blood. In this connection the following paragraph is interesting:[6]

> . . . The pressure of carbon dioxide in the alveolar air is raised during severe exercise, as might be expected, otherwise there would be no stimulus to increase the ventilation; the amount of oxygen lack is usually insufficient to produce it. It has been shown, however, that administration of carbon dioxide in the inspired air can produce a greater rise in the alveolar carbon dioxide pressure than is ever produced in exercise; nevertheless, the ventilation rate is much less than that produced by even moderate exercise. It would appear, therefore, that besides the increase in alveolar carbon dioxide pressure, some factors, as yet unrecognized, may take part in increasing the ventilation rate during exercise.

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SARCOMATA AND CARCINOMATA INDUCED IN COTTONTAIL RABBITS BY METHYLCHOLANTHRENE[1]

THE advantages of the rabbit as a host in which to investigate cancer have become apparent as the result of the study of the carcinoma that follows Shope's virus-induced papilloma in both the domestic (Oryctolagus) and cottontail (Sylvilagus) rabbit.[2] As part of our investigation of this papilloma-to-carcinoma sequence, we attempted to produce malignant tumors in cottontails by the use of methylcholanthrene, a highly potent carcinogenic agent in mice. To this end, we brought the carcinogenic hydrocarbon into prolonged contact with epidermal and mesodermal tissues, with the result that both carcinomata and sarcomata have been produced. Since the rabbit has been generally regarded as comparatively refractory to the action of carcinogenic agents, we have thought it desirable to make our positive results immediately available to the numerous workers engaged in cancer research. Our findings will appear in detail in forthcoming papers. Meanwhile, it should be emphasized that the present note is concerned only with those of our animals which received methylcholanthrene (in its vehicle) alone, *i.e.*, we are not including herein any animals which received both carcinogenic agent and virus.

The cottontail rabbits studied fall into two groups. In Group A, 1 gm of methylcholanthrene was given to each of eleven animals. The carcinogenic agent was injected into each of four sites, two subcutaneous and two intramuscular, in amounts of 250 mg in 1 ml of tricaprylin. This pure saturated triglyceride was used because of Fieser's suggestion[3] that it was desirable to administer carcinogenic hydrocarbons in a solvent with known chemical characteristics. Of the eleven rabbits, six survived for 175 days or more, the rest dying of intercurrent infection or injury. Of the six survivors, five had soft-tissue sarcomas and one an epidermoid carcinoma. The diagnosis was established in each instance by autopsy and histopathological examination. The epidermoid carcinoma, which was discovered on the 176th day, developed at a site of subcutaneous injection. The sarcomata, which were present in rabbits autopsied on from the 225th to the 295th day after injection, were multiple. Metastases had occurred in three of the five animals.

Eight rabbits comprised Group B. Each animal received from thirty-five to forty-two applications of 1 per cent. methylcholanthrene in benzene on the inner aspect of each ear. This treatment extended over a period of from 166 to 220 days. When autopsied from 228 to 362 days after the first application, seven of the eight animals were found to have developed epidermoid carcinomata. In five of the seven rabbits, metastases had occurred—to the lymph nodes in two, and to both the nodes and lungs in three.

The findings described in the present note clearly show that methylcholanthrene is an effective agent for inducing sarcomata and carcinomata in the cottontail rabbit. Its action on the tissues of the domestic rabbit and other hosts is under investigation.

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[4] Dautreband and Maréchal, *C.R. Soc. Biol.*, 113: 76, 1933.

[5] Wispelaere, *Arch. Int. Pharmacodyn.*, 56: 363, 1937.

[6] Winton and Bayliss, "Human Physiology," 2nd edition, p. 181–182.

[1] This investigation has been aided by a grant from the Jane Coffin Childs Memorial Fund for Medical Research.

[2] For related bibliography, see Peyton Rous, "The Harvey Lectures," Williams and Wilkins Company, 1936, p. 74–115.

[3] Louis F. Fieser, *Am. Jour. Cancer*, 34: 37–124, 1938.

SEX DIFFERENCES IN THE STRUCTURE OF BOWMAN'S CAPSULE IN THE MOUSE

SELYE,[1] in his observations on the effect of testosterone propionate injections in female mice, reports characteristic changes in the structure of the parietal lamina of Bowman's capsule. An instance of similar variation from the usual structure of the capsule in a normal adult male mouse was noted by Dr. Esther Carpenter of this department.[2] Comparative studies of a limited number of both adult and immature mice have enabled me to demonstrate that this modification in structure is correlated with sex.

In the kidneys studied, two quite different types of capsules were observed. The first type is that generally described in text-books of mammalian histology. The capsule consists of a double layer of flattened epithelial cells. The visceral layer of the capsule is closely applied to the capillary tuft, and the parietal layer forms a goblet-shaped structure which may or may not be separated from the visceral layer by the presence of filtrate in the lumen. The second type is similar to that described by Selye, and mentioned by a number of other workers. The visceral layer appears as usual: thin and closely applied to the endothelial walls of the loops. In the parietal layer of Bowman's capsule part or all of the cells which make up this outer layer are high cuboidal in type, with clearly demonstrable brush borders. In sections which show the neck and a portion of the convoluted tubule, the cuboidal cells of the capsule are indistinguishable from those of the tubule itself, and extend one half, two thirds, or often completely around the glomerulus to the point where the afferent and efferent arterioles are seen and where the parietal lamina is reflected back to form the visceral lamina.

In a differential count of capsules of the adult male mouse, 89 per cent. show the "abnormal" high-cuboidal epithelium which extends at least half way around the capsule. These altered malpighian corpuscles are not confined to the male. In a similar count of the normal adult female, 13 per cent. of all the corpuscles observed were thus modified. Comparisons of the histological kidney structure of the immature mouse of about 5.5-grams body weight show that same condition to exist, although to a markedly lesser degree. A differential count of the young male revealed only 25 per cent. of the capsules to exhibit the high-cuboidal cells of the parietal layer. In the immature female 13 per cent. were again found.

This preliminary publication will be supplemented by more extensive data in the near future.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

HAY VENTILATION

THE spontaneous heating of stored hay is a serious problem in many parts of the country, and large quantities of hay are damaged or destroyed each year as a result of self-heating, following storage with too high a moisture content. A dependable and economical method of preventing dangerous self-heating would result in enormous savings to the farmers of the United States.

The principle of the chimney (Fig. 1) was applied to stacks of under-cured hay in preliminary trials at the Western Washington Experiment Station in the summer and fall of 1939, to prevent, by naturally induced ventilation, the excessive heating of under-cured hay in storage. Ventilation was provided by an opening in the hay extending from the base upward through the top of the stack. In some stacks, the ventilator shaft consisted of an open frame-work of wood around which the stack was built, in others the ventilator shaft consisted merely of an opening moulded into the hay by a sheet-metal cylinder which was pulled upward as the stack was built. The only direct connection of the ventilator with the outside air was at the top.

A flow of air, induced through the mass of hay and up the chimney by the differential in temperature between the stack and the outside air, by wind movements, or by both forces working together, effectively

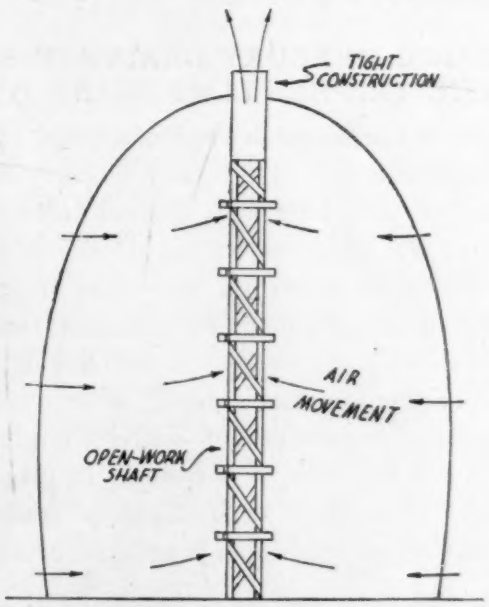

FIG. 1. Induced circulation of air through stacked hay using the principle of the chimney.

[1] H. Selye, *Jour. Urol.*, 42: 637, 1939.
[2] E. Carpenter, personal communications.

prevented excessive heating of under-cured hay (having a moisture content up to 37.0 per cent. in stacks so far tried).

Three round stacks consisting of approximately 6½ tons, 3 tons and 2¼ tons, and having when built, moisture contents of 37.0, 29.4 and 35.3 per cent., respectively, reached maximum temperatures of 112°, 100° and 76° F., respectively. Ventilation in the 6½ ton stack, provided by a round moulded shaft one foot in diameter, was believed inadequate.

An unventilated 8½ ton stack containing 37.2 per cent. moisture when stacked, reached a maximum temperature of 148° F. and contained considerable moist brown hay when opened.

A fourth stack, rectangular in shape, containing 9 to 10 tons of hay, carrying 21.2 per cent. moisture, was so constructed that half the stack was ventilated and half not ventilated. Maximum temperatures in similar locations in the ventilated (68° F.) and unventilated (92° F.) portions of the stack showed a difference of 24° F. in favor of the ventilated hay. A slight difference in quality of the hay in favor of ventilation was noted.

Frequent velometer readings in the chimney of the ventilated part of the stack showed that the upward flow of air in the ventilator shaft commonly reached a speed of 150 feet per minute with occasional velocities of 250 to 300 feet per minute.

This principle of hay ventilation is believed applicable to most existing hay barns and mows, as well as stacks, and seems to offer a hope of eliminating much of the hazard of spontaneous heating of hay, at small cost for installation and no cost for operation.

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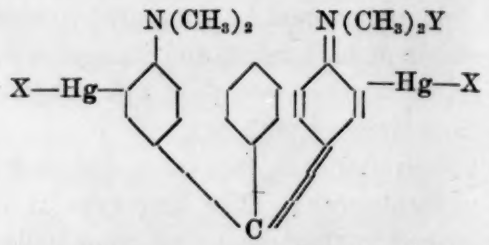
ORGANIC MERCURY DERIVATIVES OF BASIC TRIPHENYLMETHANE DYES

BECAUSE of the distinctive characteristics of the basic triphenylmethane dyes the organic mercury derivatives of these dyes would seem to present interesting bacteriological and pharmacological possibilities. It has proved difficult to mercurate basic dyes directly,[1,2] but I have found that the mercury compounds can be prepared by a two-stage process in which a derivative of the basic triphenylmethane dye is mercurated and the resulting mercury compound converted into the dye. Proceeding in this way, it is possible to prepare series of mercury compounds of both the colorless and colored forms of amino triphenylmethane derivatives.

For example, 4,4′ bis-dimethylamino-triphenylacetonitrile is readily mercurated, and the mercurated nitrile can then be converted into the corresponding mercurated malachite green by means of a photochemical reaction. Both mono- and di-mercuri derivatives are produced smoothly in the mercuration.

The dimercuri malachite green probably has the formula:



Here *X* and *Y* are anions, but not necessarily the same anions.

The mercury in this compound is relatively stable to ammonium sulfide, which, in presence of ammonium hydroxide, gives only a colorless organic mercuric sulfide, which remains colorless for some time at room temperature.

When *X* is an anion which ionizes readily from the mercury the salts of even this dimercurated dye are generally quite soluble in alcohol, and the alcoholic solution, if not too concentrated, may be diluted with water without precipitation of the dye. From such solutions chlorides, even in low concentration, precipitate the insoluble chloromercuri compound. However, dicyanomercuri malachite green—where *X* is *CN*—has the solubility of the ionizable salts and, in addition, is soluble in presence of moderate concentrations of chloride ion.

Further details of these reactions and compounds will be published elsewhere. The chief purpose of this note is to call the existence of these new substances to the attention of bacteriologists and pharmacologists. I have a little of the dicyanomercuri malachite green and should be glad to supply small samples to interested scientists while my stock lasts.

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POINT PLEASANT, N. J.

[1] F. C. Whitmore and G. J. Leuck, *Jour. Am. Chem. Soc.*, 51: 2782–2784, 1929.

[2] L. Chalkley, *Jour. Am. Chem. Soc.*, 47: 2055–2061, 1925.

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